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__________________________Subject________________________________

Effect of storage time and salinity on germination of durum wheat (*Triticum Durum* Desf.)

Supported in, 23/06/2022

In Front of the Jury:

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Présentée par :

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Thème

Effet de la durée du stockage et l salinité sur la germination du Blé Dur *(Triticum Durum* Desf.*)*

Soutenu le, ………………………..

Devant le Jury :

Mr. GADOUM A.	Président	M.A.B	Univ-Tissemsilt
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بسم الله الرحمن الرحيم

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Dedicate

I dedicate this modest work to the one who gave me life, who sacrificed herself for my happiness and my success , to my mother. To my father, who was my shadow during all the years of studies, who ensured to give me the help , to encourage me and to protect me,

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To the person closest to my heart KENZA

to all those who love me, to all those I love, I dedicate this work!

To my buddy in this work: ABDELLAH

HAMADA

Dedicate

This work is dedicated to:

The sake of Allah, my Creator and my Master, My great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life.

My mother and my father , who never stop giving of themselves in countless ways.

My brother "Abdelmoumen" my right hand .

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My football team's players. "JSTH" and "CSAT"

to all those who love me, To my buddy in this work: HAMADA

ABDELLAH

List of abbreviations

% : pourcentage

°C : Degre Celsius

Cm :centimetre

DF :degree of freedom

F : Test exact de Fisher

FAO : food and agriculture organization of the united nations

g :gramme

ha : Hectare

ITGC :Technical Institute of Field Crops

Kg: kilogramme

mg : milligramme

mL : millilitre

mm :millimetre

mM :millimolar

MS: Mean of the Squares

EC :electrical conductivity

ds :Desi Siemens

NS :not significant

Na^+ :sodium

Cl^-:chloride

P : Probability

S :significant

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Introduction

Introduction

Among the major crops with an important place in nutrition to provide daily calories and protein intake, cereals such as wheat, rice and corn are the most important (Kizilgeci et *al*., 2021). Among these, wheat is a domesticated plant species and is the main staple food in the world (Tack et *al*., 2015; Iqbal et *al*., 2021; Giraldo et *al*., 2019).

The reserved harvested area for wheat is estimated at 38.8%, the latter provides much more protein per gram (12 to 15%) than rice or maize (2 to 3%) and is therefore a better cereal of choice. Nevertheless, its production levels are significantly lower than those of rice and maize (FAO, 2017).

Agriculture is an important element of rural development and the national ecocnomy in Algeria (LaoubietYamao, 2012). Most Agricultural activity in Algeria is located in the north area. Nevertheless, in recent years, Saharan agriculture has taken an important place in terms of production and desertification of crops. The main crops are annual crops, including Mainly field crops such as grain, fodder, beans and potatoes**(**Abdelkader,2014).

In Algeria, the yied production rate during the period 2010-2017 was estimated at 41.2 tons per year. This production is not sufficient for the population's needs, due to the inefficient use of the inputs of grain production, and to the deterioration of agricultural lands designated for grain production due to drought and desertification (Hamadene et *al*., 2022)
Cereals are the main crop grown by farmers in Algeria, covering between 3 and 3.5 million hectares per year. This is almost 40% of the total agricultural land in Algeria(Abdelkader,2014).Durum wheat,*Triticum turgidum subsp. durum* Desf is an important economic and nutritional crop. It grows mainly in the Mediterranean(Ami et *al*.,2020)
Salt stress is among the abiotic stresses that affects more than 20% of global cropland and is continuously increasing due to climate change and harmful anthropogenic activities (Arora, 2019). It can cause about 50% of production losses (Acquaah, 2007). Thus, the population explosion presents as a pressure on global food security, as the global food supply must be increased by up to 70% by 2050 (FAO, 2009). About 36% of the world's population depends on wheat as a staple food.

Salinity leads to different morphologies, physiology, biochemistry and molecules Changes affecting plant growth and productivity (borrely et *al*.,2011), In Algeria, some 3.2 million hectares are currently threatenedSalinity. due to developing saltAffected countries, salinity has become aFood Supply (Zoubida et Gherroucha,2017).

Introduction

The importance given to seed storage has been recognized since man began to domesticate plants. Thus, for some time, farmers have had to save viable seed from one growing season to the next. The seeds of different plant species react to varying degrees to the surrounding environment before and during storage (Tiwariet Das, 2014).

It has been estimated that 25% to 33% of the food crop including seeds is lost during storage. Consequently this affects global food security. However, this situation is worsening especially in developing countries experiencing food shortages, the impact is even greater rear after year, and the farmers struggle to make seeds a staple crop (Fao, 2018).

The seed germination is the most crucial stages in plant development (Baskin & Baskin, 2014). During storage, many factors are considered to be the main agents that affect seed viability and vigor (Baskin et Baskin, 2014). Physico-chemical factors such as moisture content, atmospheric relative humidity, temperature, initial seed quality, physical and chemical composition of seeds, gas exchang , storage structure, packaging materials are the most cited (Doijode, 1988;Rajjou et Debeaujon, 2008). However, as seeds do not indefinitely conserve their germination capacity, a high viability and germination rate depends, in large part, on storage time and conditions (Baskin et Baskin, 2014).

Understanding the influences of different storage period on seed viability in response to abiotic stress could provide valuable insight into wheat develeppement.Germination constitutes the first phase of wheat development and which conditions the subsequent development of the different stages of durum wheat. For this, the objective of this study is to evaluate the response of a wheat genotype from different storage dates and under the effect of salt stress.

Chapter 01 : wheat

I.1 Origin and distribution of wheat

Regarding the localization of wheat domestication, we considered to this day that it happened in the fertile crescent, Jordan River Valley and Jordan River Areas bordering Palestine, Iraq and Iran's western border (Doussinault et *al*., 1992)

The spread of wheat to Africa by the oldest road gained Egypt to – 6,000 before today and continued to Sudan and Ethiopia to the south and Libya to the east. Other routes of introduction were from Greece and Crete, some wheat joined also Libya; others, coming from the south of the Italian peninsula and Sicily, reached the coasts of Tunisia, Morocco and Algeria (Bonjean, 2001)

I.2 General description of the plant Durum wheat (*Triticum durum*)

Durum wheat (*Triticum turgidum* ssp. durum) is a monocotyledonous plant of the family Poaceae and **Triticaceae**, belonging to the genus Triticum. For commercial production and human consumption, durum wheat is the second most important variety of wheat after common wheat (*Triticumestivum* L.)

Durum wheat is a medium-tall annual weed with flat leaves and terminal inflorescences consisting of perfect buds(Bozzini, 1998). Like soft wheat, there are semi-dwarf varieties of durum wheat. The root system consists of seed roots that are produced by the seedling during germination and adventitious roots that later grow from the base of the plant to become the permanent root system. Stems cylindrical, erect, mostly hollow, divided into internodes. Some durum wheats have strong stalks(Clarke et *al*., 2002).

Culms (tillers) are produced from auxiliary buds at the base of the main stem. The number of culms formed depends on the variety, growing conditions and planting density. Under normal field conditions, a plant can grow a total of 3 stalks in addition to the main buds, but not necessarily all of them have seeds (Bozzini, 1988). Like other grasses, durum wheat leaves consist of a base (sheath) that wraps the stem and a terminal portion that is linear with parallel veins and tips. At the base of the leaf sheath is a thin, transparent membrane (ligule) with two small lateral appendages, the pinna. The main stem and each culm form terminal inflorescences.

The inflorescence of durum wheat is a spike with a rachis bearing spikelets separated by short internodes (Bozzini, 1988). Each spikelet consists of two glumes (bracts) enclosing two to five florets, all borne distichously on a rachilla. Each floret is enclosed by bract like structures called the lemma and the palea. Each floret is a perfect flower, containing three stamens with bilocular anthers and a pistil bearing two styles with feathery stigmas. Mature pollen is fusiform, normally containing three nuclei. Each floret has the potential to produce a one-seeded fruit called a caryopsis. Each seed contains a large endosperm and a flattened embryo located at the apex of the seed and close to the base of the floret.

Durum wheat is best suited to regions with relatively dry climates, with hot days during the growing season and cool nights, typical of Mediterranean and temperate climates. The temperature for seed germination is as low as 2°C, but the optimum temperature is 15°C (Bozzini, 1988).

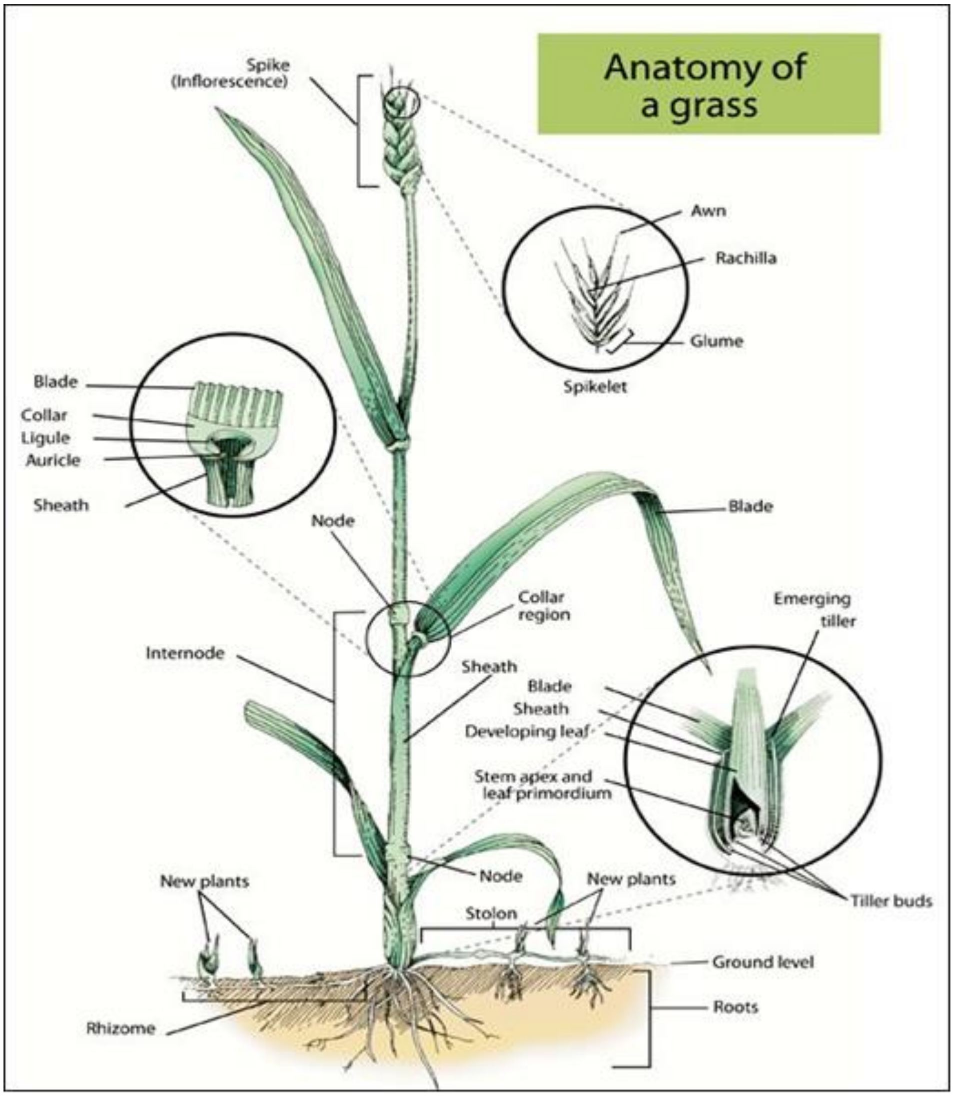


Figure 1. Anatomy of plant (Nour . 2017)

I.3 Seed

A seed is an embryonic plant covered by a mature seed coat Eggs are grown after fertilization. A seed consists of three main parts − Embryos, seed coats and endosperm.

The embryo is the most important part Because the various tissues that make up a plant develop from its cells. That The endosperm contains nutrients, while the seed coat protects the embryo. That Plant seeds are not only reproductive organs, but also important organs source of dietary protein (AdeolaetAnofi,2021).

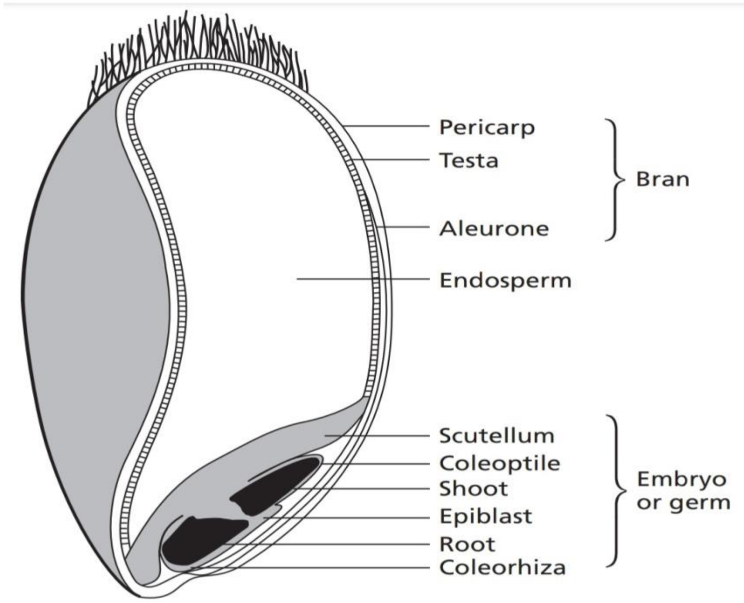


Figure02. Cross-sectional structure of wheat grain (McDonald et *al*., 2011).

I.4 Germination

Germination begins when the grain absorbs water and ends the appearance of a root. It divided in three phases (Figure 3, Julie et Jan,2008):

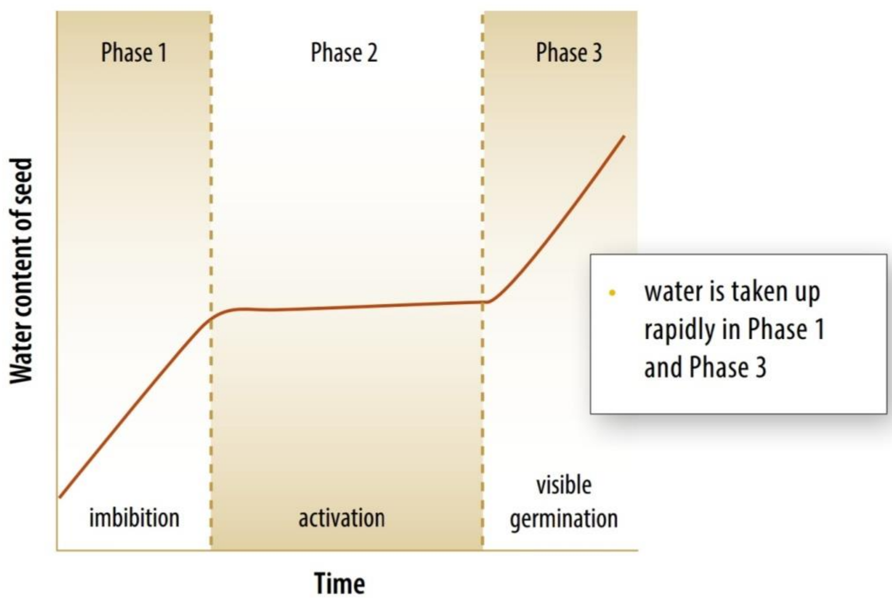


Figure03. Pattern of water uptake by wheat seeds

I.4.1 Phase 1. Water absorption

The first stage begins when the seeds start to absorb water. Typically, wheat seeds need to be around 35 to 45 percent of their dry weight in moisture to begin germination. Water vapor can start the germination process as quickly as liquid. The relative humidity of wheat seeds is 97.7%. The soil is so dry that the roots cannot absorb water, but the relative humidity is still 99%, much higher than dry seeds. So even in dry conditions, there may be enough moisture for the seeds to pick up and start stage 1, but it will take longer.(Akhter et *al*.,2008 ; Acevedo et *al*.,2002)

I.4.2 Phase 2. Activation

Once the embryo swells, it produces hormones that stimulate enzyme activity. These enzymes break down starch and Converts proteins stored in semen into sugars and amino acids that power the developing embryo. If the seed dries out before the embryo begins to grow, it can still survive. Stage 2 continues until the seed coat ruptures, the first visible sign of germination (Julie etJan,2008)

I.4.3 Phase 3 Visible germination

At third stage, the embryo begins to grow noticeably. The radicle emerges quickly, followed by other primary roots and coleoptiles. Enzymes produced in stage 2 mobilize sugars and amino acids stored in seeds and allow their transfer to the developing embryo (Julie et Jan,2008).

I.5Emergence

When the first primary root emerges, the coleoptile breaks through the seed coat and begins to push towards the surface. Emergence is when the coleoptile or first leaf becomes visible above the soil surface (Schillinger et al.,1998 ; Acevedo et *al*.,2002)

I.6 Coleoptile formation

The coleoptile develops well in the embryo and forms a thimble-shaped structure covering the seedling duct and scion. Once the coleoptile emerges from the seed, it will grow longer until it breaks through the soil surface.

The fully elongated coleoptile is a tubular structure about 50 mm long and 2 mm in diameter. It is white except for two chlorophyll-containing tissues. The end of the coleoptile is spherical and closed except for a small hole, 0.25 mm long, just behind optimal.

When the coleoptile senses the light, it stops growing and the first true leaf passes through the hole at the top. So far the plant has lived off internal reserves seed (Julie et jan,2008).

I.7 Wheat growth and development

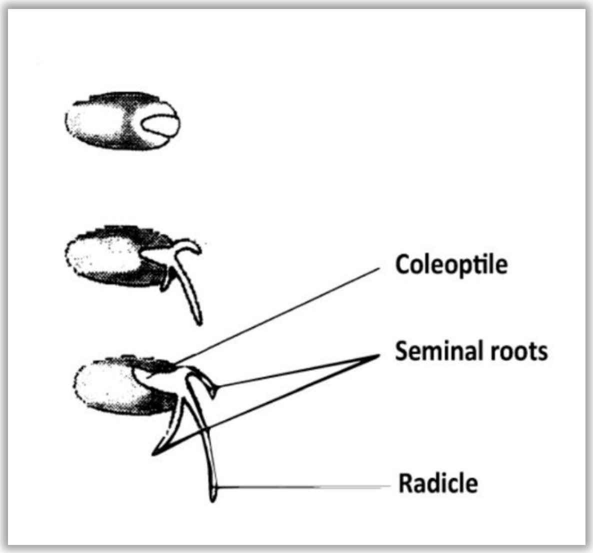
The ten major growth stages that a wheat plant goes through during its life cycle are Farmers are familiar (Brian,2018)**.**

I.7.1 The wheat kernel

The mature wheat kernels (caryopsis) consist of approximately 83% endosperm,14.5% bran and 2.5% embryo. Once germination begins, the endosperm provides A developing plant with energy until its roots are established and re-propagated Leaves allow it to harvest energy from the sun. Embryos of mature wheat kernel have gone through the first phase of factory development prior to core separation mother plant. In the mature nucleus, the embryo contains the coleoptile**,** who protects first During germination the leaves travel through the soil to the surface, the radicle, Becomes the first root, the primordium develops into the first three leaves and seminal root (Brian,2018).

I.7.2 Germination

Germination begins with absorbing water (sucking out) from lost wheat Rest after harvest. Once the embryos are fully absorbed, plant development resumes. And Growth resumes and the radicle and coleoptile emerge from the seed (Figure 5). First Three seed roots are produced, then the coleoptile elongates and pushes the growth point towards the ground (Willenborg et *al.*,2005)



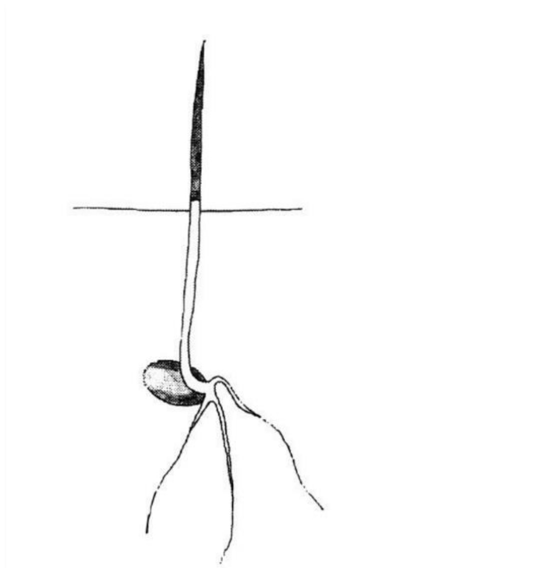


Fig 05.Wheat germination. (Brian,2018) **Fig 04**.Wheat emergence.Zadoks stage 10

I.7.3 Seedling stage

The seedling stage begins with the appearance of the first leaf (Figure 6) and ends with the appearance of the first leaf. Create the first tiller. Up to six seed roots and three leaves support the plant stage. The crown of the plant usually becomes apparent after the third leaf surfaced (Brian,2018).

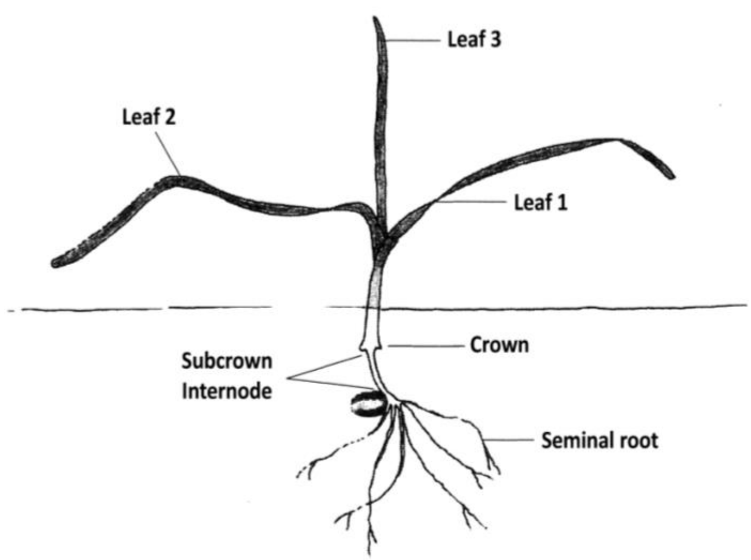


Figure06.Wheat seedling with three leaves and a developing crown.Zadoks stage 13. Haun stage 2.6(Brian,2018)

I.7.4 Tillering stage

Development of shoots and secondary roots occurs soon after crown formation or crown root system (Figure 7). The crown root system provides most of the nutrients to the plant Nutrients and moisture during the growing season (Brian,2018)

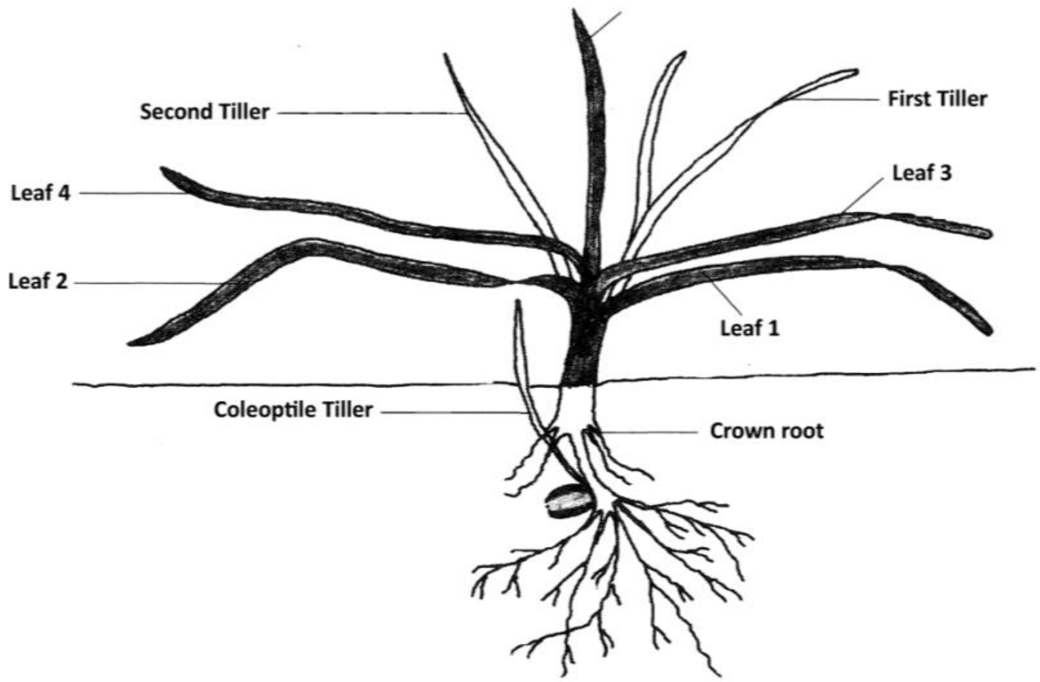


Figure07. A wheat plant with five leaves, two tillers, and a well - developed crown.Zadoks stage 22. Haun stage 4.7 (Brian,2018)

The distance fromthe wheat kernel and the crown is determined by the length of the grain lower internode (Figure 6). The internodes of the lower crown may be elongated by several inches, crown is typically positioned within 1.2 inches (3.0 cm) of soil temperature floor surface. In Saskatoon, crown depths are 0.7 inches (1.8 cm) and 1.2 inches (3.0 cm). Soil temperatures at sowing were 18 and 11 °C, respectively. The recommended planting depth for winter wheat is less than 1 inch.

Roots, leaves, tillers, and spikelets on the head of a wheat plant develop from primordium node. Although the first mainspring will not be produced until the third blade is fully pushed out,Emergence of late stockists is usually synchronized with each subsequent new appearance

Leaves develop on the main stem. For example, the appearance of the fifth leaf is normal With the advent of the second crown tiller (Figure. 07), aThere are auxiliary buds (primordium) at the nodes at the base of the second leaf (leaf axils). Likewise, a tiller can start producing its own subtillers once it has three fully developed leaves.

Each tiller produced represents the potential of the wheat plant to develop another The stem is intact, with its own leaves, roots and head. Root and shoot development of plants are synchronous, so the number of crown roots is related to the number of leaves produced. However, rooting of tillers is usually delayed until the third leaf appears.As a result, tillers that do not produce at least three blades are generally not competitive Dies once the stem elongation phase begins.

Under favorable environmental conditions, coleoptile stockings can develop (Figure 07). That Evolution of coleoptile tillers veins is not closely synchronized with the evolution of the rest plant, but its appearance usually matches the appearance of the third leaf main drive. They develop and separate from the nodes at the base of the coleoptile The main branch is in the lower crown internode. However, when the wheat is sown flat, the next crown is Internodes do not expand, coleoptile tillering will start at the side The crown of the main bud.

Significant changes in wheat plant development occurred at the end of the tillering stage. At this time, the growth points of the main branches and new shoots stop sending new leaves, and start Production of reproductive structures. Changes in growth points herald the end of the economy Vegetative and the start of the reproductive season.

Early maturing spring wheat cultivars change from the vegetative to the reproductive phase after seven to eight leaves have been initiated on the main shoot. However, many commercial wheat cultivars have a vernalization (growth at low temperature - see Chapter 7) or photoperiod (growth under long day length) requirement that extends the vegetative period allowing for the production of more main shoot leaves and a larger number of tillers. An extended vegetative period due to a vernalization requirement is the main reason why more heat units are needed to produce a winter than a spring wheat crop. (Brian,2018)

I.7.5 Stem elongation or stem jointing stage

During the tillering stage, the nodes from which the leaves grow are retracted at the crown. Once the join starts, the inter-node area expands and the nodes and growth points move From the crown upwards form a long, stiff stem that supports the head. the emergence of The first node can often be identified without dissecting the plant by squeezing it The base of the interdigital (largest) main stem.

Each successive tiller on a wheat plant typically has one less leaf than its predecessor. That Synchronize the start of the stem elongation phase of the main stem and the tillers. Simultaneous growth and development at this stage ensures that no more than one The maturity of all heads on the plant varies by a few days.

Spikelet development on the microscopic head is usually completed by the time the first node is 0.4 inches (1 cm) above the soil surface. The terminal spikelet is produced . A rapid loss of younger, poorly developed tillers also normally starts at this stage.

Elongation of the stem or jointing stage ends with the appearance of the last (flag) leaf (Brian,2018)

I.7.6 Booting stage

The developing head in the flag sheath increases significantly during development the booting stage. The booting stage ends when the first awn emerges from the flag leaf sheath And the head begins to open the sheath (Brian,2018)

I.7.7 Heading stage

The head stage extends from the point where the tip of the head emerges from the flag leaf Drop off when the head is fully emerging but has not yet begun to bloom (Zhuet*al.*, 2016)

I.7.8 Flowering or anthesis stage

The flowering or anthesis stage continues from the beginning to the end of the flowering period. During this period, pollination and fertilization take place. Properly sync all heads of wheat Plant flowers within a few days and immediately begin to form embryos and endosperm Fertilize (DeVries.1971)

I.7.9 Milk stage

The developing endosperm begins to be milky white A liquid with an increasing solids content as the milk stage progresses. At the same time, Kernel size increases rapidly this stage (Brian,2018)

I.7.10 Dough development stage

Kernel formation is completed during the dough development stage. Kernel accumulation Most of its dry weight during dough development.transport nutrients from leaves, At the end of the hard dough stage, the stem and spike of the developing seed are intact. That The developing core is physiologically mature at the hard dough stage, although it still contains About 30% water (Brian,2018)

I.7.11 Ripening stage

The seed loses moisture, and any dormancy it may have had, during the ripening stage (Brian,2018)

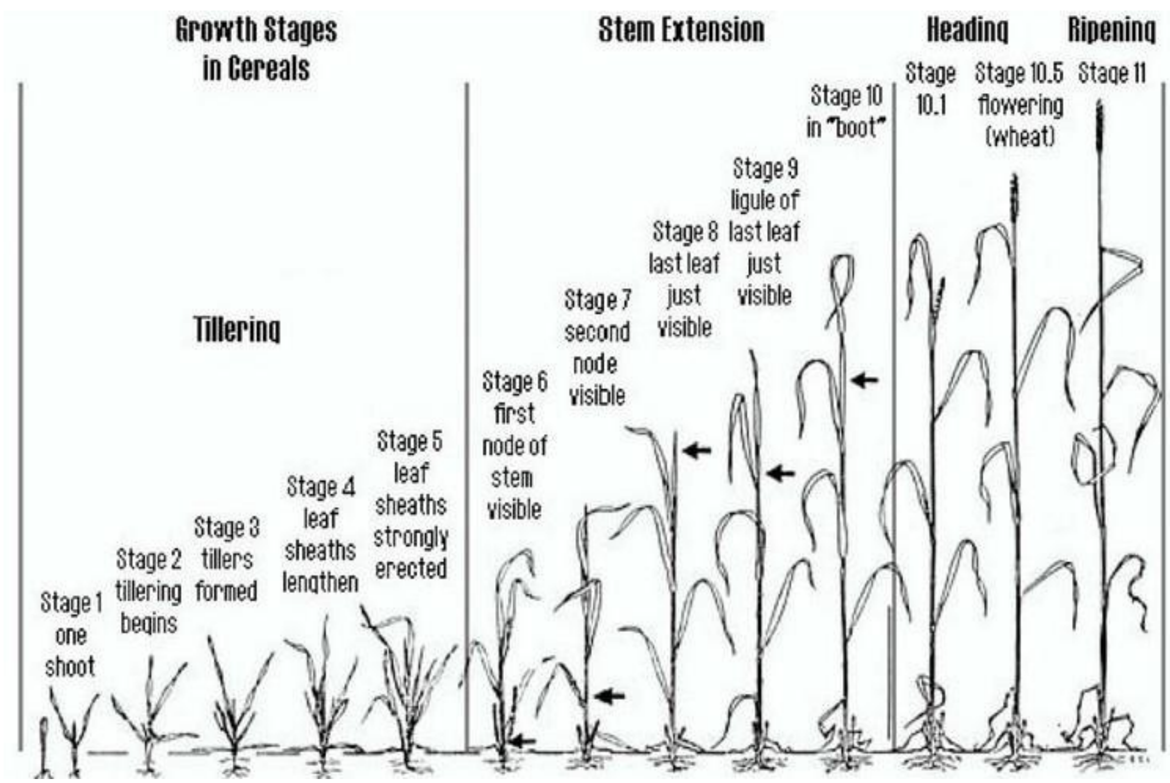


Figure 08. Development-of-cereals-according (Sadovski et Ivanova ,2021)

Chapter 02

stress and salinity

II Stress

II.1 Definitions of stress

It is a series of environments that bring about change physiological damage, injury and slowed growth and development. Stress is a fundamental mechanical concept defined by engineers and physicists as the force exerted by the surface entities of an object in response to stress. Objects resist deformation or dimensional changes (Hopkins, 2003).

II.2 Abiotic stresses

Abiotic stresses such as drought (water stress), over-irrigation (stagnant water), extreme temperatures (cold, frost and heat), salinity and mineral toxicity can adversely affect the growth, development, yield and seed quality of crops and other plants .For the future, freshwater scarcity is expected to increase, and ultimately the intensity of abiotic stresses. Therefore, there is an urgent need to develop abiotic stress-resistant plant varieties to ensure food security in the years to come. A plant's first line of defense against abiotic stress lies in its roots. Plants have a high chance of surviving under stressful conditions if the soil they are in is healthy and biologically diverse. One of the main responses to abiotic stresses such as high salinity is the disruption of the Na^+/K^+ ratio in the cytoplasm of plant cells. The plant hormone abscisic acid (ABA) plays an important role in plant adaptation to environmental stresses such as high salinity, drought, low temperature or mechanical damage (Seki et *al*.,2007).

II.3 Different types of stress

II.3.1 Drought stress

Drought stress is the most common environmental factor limiting crop productivity (Bray, 1997), and global climate change is increasing the frequency of severe droughts (Dai, 2012). The sheer diversity of plant species growing in climatic regions including extreme aridity suggests that plants evolved in nature to withstand drought stress with a range of morphological, physiological and biochemical adaptations (Bohnert et *al*., 1995).

II.3.2 Water stress

Water stress can be defined as the ratio between the amount of water a plant needs to grow and the amount of water available in its environment, knowing that a plant's useful water reserve is the amount of soil water excreted by its roots that the system is accessible (Laberche, 2004). Plant water requirements depend on the degree of transpiration, or evapotranspiration, which involves water loss at the leaf and soil levels (Laberche, 2004).

II.3.3 Salt stress

Salt stress is defined as excessive salt concentration. The term saline stress applies primarily to excess ions, particularly Na^+ and Cl^-(Hopkins, 2003). Soil salinity is one of the main abiotic stresses limiting the growth of cultivated plants. This salinity may be natural or induced by agricultural activities such as irrigation or the use of certain types of fertilizers (Jabnoune, 2008).

II.4 Effects of salinity on germination

The seedling stage is the most variable period of a plant's life cycle, and germination determines when and where seedlings begin to grow. This germination stage is usually limited by soil salinity and is more sensitive than other stages (Said et *al*., 2011).

Seeds respond to salt stress, reducing the total number of germinated seeds and delaying the onset of the germination process. One of the reasons for the inhibition of bacteria in the presence of salt is the change in hormone balance (Rejili et *al*., 2006)

II.5 Effects of salt on growth and development

The direct response to salt stress is to reduce the rate of leaf area expansion, which stops when the salt concentration increases (Wang and Nil, 2000), and salt stress also leads to a reduction in leaf area leaves, stems and roots of drought and fresh biomass (Chartzoulakis et Klapaki, 2000).

II.6 Responses of plant to salt stress

There are two types of struggles with salinity, the human help response and the plant's natural adaptive response. The natural battle strategy between plants is based on three strategies.

1) Na^+ ions are extracted from the cytoplasm due to malabsorption.

2) Na^+ ions are eager to enter the vacuole.

3) They are accumulated in leaves due to preference.

Genotypes with high concentrations of Na^+ ions in leaves have been shown to be very sensitive to salinity, and generally those genotypes that tolerate high concentrations are those that transfer Na+ ions into leaf cell vacuoles. Salt-tolerant plants get rid of the harmful effects of sodium chloride (Hussain et *al*., 2019)

II.7 Morphological adaptation responses against salinity in plants

Types of plants that are adapted to their environment (halophytes) or less affected by their environment (glycophytes), the duration of exposure to salt in irrigation water affects growth and these factors cause plants to develop various mechanisms to combat adverse effects (Munns et Tester, 2008)

II.7.1 Germination

Seed germination is one of the important stages of a plant, but it can be hindered by salt. Salt stress has negative effects on plant uptake and root growth (Shahzad et *al.*, 2019) . Salt-induced reduction in germination and reduced plant root growth is associated with ion toxicity and osmotic stress (Katembe WJ et *al*, 1998).Reduced germination was observed in plants grown under salinity. In particular, wheat in crops is greatly affected by salt, and the germination rate decreases. Salinity also delays germination time (Lin et *al*., 2012)

II.7.2 Seedling development

To enable plants to continue their life activities, seedling development under salt stress plays an important role. Plant biomass accumulation and stunted plant growth are among the consequences of salinity, the greatest effect of which is its role in leaf area expansion (Shahzad et *al.*,2019). There is an inverse relationship between seedling development and salinity, although some salt-tolerant plants appeared to have increased biomass assemblages at high salinity. Salinity also negatively affects seedling fresh and dry weight, plant length, and root surface of plants (Shahzad et *al.*, 2019).

II.7.3 Water relations

Excessive Na^+ and Cl^- ions prevent water uptake by plants by increasing soil osmotic potential, which can negatively affect plant growth by reducing water uptake by plant cells (Munns,2002). In the case of increased salinity, there is a negative correlation between osmotic potential and water potential with pressure, which means that a decrease in these two factors is observed at the same time as salinity increases (Shahzad et *al*.,2019). Water-based osmotic stress causes stomata to close, which in turn disrupts photosynthesis by preventing the flow of carbon dioxide. Regulating water flow is a key solution to eliminate these disadvantages (Flexas et *al.*,2006). Furthermore, the use of canal water may be preferable to saline groundwater when controlling salinity, especially in crops. The use of gypsum is also one of the cases in which sewers are not available (Zaka et *al*.,2009).

II.8 Salinity

Salinity is one of the most brutal environmental factors limiting crop productivity, as most people are sensitive to salinity caused by high salt levels.

The salt concentration in the soil and the affected land area is gradually increasing. The concept of salt pan farming is proposed for remediation of saline and degraded soils (Hniličková et *al.*,2019).Salinity effects are the result of complex interactions between morphological, physiological and biochemical processes. Point out that salinity has a negative effect on both germination and plant growth processes (photosynthesis, respiration and transpiration), nutrient balance, membrane properties and cellular homeostasis, enzymatic and metabolic activities.

Salt levels decreased photosynthetic carbon assimilation, stomatal conductivity, and photosynthetic electron transfer efficiency. The most damaging effects of salt stress are Na^+ and Cl^- ions in plant tissues.The entry of both ions into cells causes a significant ionic imbalance and excess absorption can cause significant physiological failure (Hniličková et *al.*,2019).

II.8.1 Causes of salinization and salt-stress to plants

There are multiple sources of salinity that can affect crop production on farmland.The type of salt source is very important, but the accumulation of salt in the root zone also depends on other factors, such as soil type, climate, and soil and crop management. For example, rough-textured soils in humid climates have good infiltration rates and sufficient rainfall to leach salt into deeper soil layers. On the other hand, if the texture is fine, the salting process is less effective Soil and arid and semi-arid conditions. Depending on the soil's source material, location, topography, and climate, the area may develop salinity due to salt deposition from one or more of the following sources (Yadav et *al.*,2011)

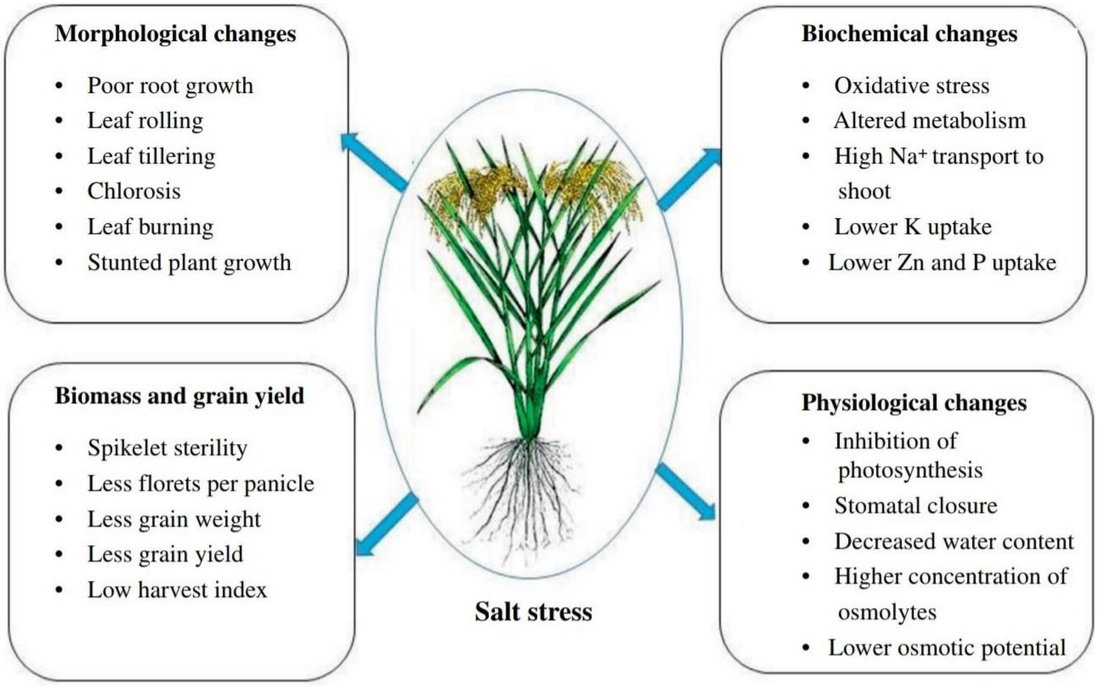


Figure 09. Schematic of the multiple effects of salinity on plant growth, development, and yield attributes (Riaz et *al.*,2019)

II.8.2 Primary salinity

The salinity formed by the saline-alkali soil material is called primary salinity. In addition to insoluble aluminosilicates, soil components may also contain carbonates, bicarbonates, chlorides, sulfates, and phosphates of calcium, magnesium, sodium, iron, manganese, and aluminum. These salts are transported and deposited as part of the soil parent material. In addition, in situ weathering of various insoluble minerals also provided cations and anions in solution, leading to increased soil salinity (Riaz et *al.*,2019)

II.8.3 Irrigation water as a source of salinity

Ordinary field soils irrigated with brine can become salinized (secondary salinization) EC ≤ 1 dS m^{-1} within a few years.It is considered good for irrigation. But it depends on the situation type of soluble salt, a single 4-acre-inch irrigation with water of 1EC Ds m^{-1} can add about 260-300 kg of salts into the field soil. In addition to the salt concentration in the water and the amount of water per unit with irrigation, the accumulation of salt in the soil also depends on the type and frequency of irrigation, crop rotation, soil type and climate.

Wastewater for irrigation and industrial wastewater are also minor sources salinity. The EC of wastewater is mostly higher, depending on the source. in a third world Country, sewage discharges into rivers and canals which result in salinization of otherwise good quality water (Ec≈0.3-0.5 dS^1) groundwater quality. The amount of water pumped for irrigation varies with the inner layer, location tly with inner stratum, location (nearness of some big water body like river, canal, lake, etc.), pumping depth and climate. in arid and semi-aridIn some areas, groundwater is predominantly salty, while in wet areas, precipitation can be high Causes electrolyte dilution (Riazet*al*.,2019)

Coastal salinity

Seawater with conductivity up to 50 dS m^{-1} can cause salinity problem in coastal areas. Possible ways in which seawater can reach land are inundated at high tide, penetration by rivers and estuaries, inflows of groundwater and salt-containing aerosols. The effects of floods are mostly localized and confined to the coast. Other factors, on the other hand, can cause salinity several kilometers inland from coastal areas. By transporting salt seawater splashes and dry salts away from coastal areas over long distances, the air can reach a salinity of around 20 -200kg ha^{-1} $year^{-1}$ (RIAZ et *al* ,2019)

Fossil salinity

These continents did not have their present size, shape and location in the past. Instead, some land areas lie beneath the ocean and come later. Salt deposits that settled out of seawater at that time still exist today in deeper layers of soil and are known as fossil salts. These salts sometimes surface when pumping irrigation water or digging canals (Riaz et *al.*,2019).

II.8.4 Other salinity sources

There are several other sources that may contribute little to salt build-up in agriculture. One of them is the addition of artificial fertilizers and organic fertilizer. Mostly pure saltsare used as fertilizers and the minor role of their addition can be easily judged. Whereas saltthe addition of organic fertilizers varies greatly depending on the type and source of the manure. For example,adding organic matter via sewage sludge or industrial waste would add more salt compared to for farmyard manure and poultry.

Rainwater can be another minor source of salinity in agricultural land. after early showersThe long dry season can add several kilograms of salt per hectare per year. because of air pollutionIn urban and industrial areas, the contribution of rainwater is significantly higher thanRural areas and forests (Li et *al*.,2020).

II.8.5 Role of poor soil and crop management

Soluble and sparingly soluble salts move up and down with water in the soil profile. Positive water balance brings salt from the root zone into the lower soil layer. On the other hand, lack of leachate in irrigation water can lead to water evaporation More than is added by precipitating salts in the topsoil. So maintain leaching Fractions in irrigation are important to counteract the effects of small and moderate salt additions Agricultural land.

-Uneven fields can cause salinity due to uneven water levels evaporation.

-Leaving the bottom without watering can also lead to salinization of the top ground.

-Land leveling, or sometimes removal of topsoil to lower field levels Irrigation purposes may expose a layer of salt from the subsoil.

-Poorly managed irrigation systems that allow water to pass from one field to another Causes salt to be transported from saline to non-saline ground.

-Use drip or sprinkler systems to irrigate crops continuously without occasional use Flooding can lead to salinization due to the lack of leachate fractions in both systems (MULLA et SCHEPERS.1997 ;Sharma et Minhas.2005)

Chapter 03
Storage

III Seed storage

Storage of seeds is the preservation of seeds in a controlled environment conditions for maintaining the viability of seeds (germination and vigor) for a long time from harvesting to final sowing by the farmer. This the entire storage period covers several processes and places. To the fullest meaning, storage begins at physiological maturity and ends with germination in field. The storage period can be divided into five stages:

1. Harvest maturity
2. Drying and threshing
3. Processing
4. Distribution and marketing
5. On-farm storage (FAO,2018)

III.1 factors contributing to seed deterioration

Seed spoilage is a natural process of seed quality degradation over time due to exposure to challenging external factors. Several factors contributed to this The rate at which seed spoilage leads to physical, physiological and biochemical effects Seed changes. These changes reduce seed vigor and eventually led to his death.

Seed spoilage is affected by a variety of factors at different stages

- Pre-harvest
- Harvest and post-harvest
- Warehouse storage
- Transport and transit (FAO,2018 ;Magan et *al*.,2014)

III.1.1 Pre-harvest

Seed storage begins in the field, and high-quality seeds require optimal conditions. crop factor. Seed quality (germination capacity, viability, vigour and health) Influenced by site location and site weathering (exposure to adverse conditions that lead to high relative humidity and high temperatures), more special

-Precipitation after maturation and physiological maturity exposes seeds to heat and pre-harvest wet conditions, resulting in reduced seed quality. Heavy and prolonged rains lead to increased moisture content, accelerating Seed respiration and possible fungal activity, leading to rapid seed deterioration quality.

-May lead to adverse environmental conditions during seed filling and ripening During forced ripening of seeds, resulting in low yields and poor quality.

-Delayed harvest beyond optimum maturity prolongs field exposure and Increase seed spoilage. The location of seed production not only has a significant impact on yield, but also Regarding seed moisture management and overall quality (viability, germination capacity, seed vigour and health) (FAO, 2018; Payn, 2002)

III.1.2 Harvest and post-harvest

The quality of the seeds depends on the treatments used during harvest and after harvest. in drying, threshing, processing, Collection, Handling and Shipping. In fact, mechanical damage is a big problem Causes of seed spoilage during harvest and post-harvest stages. Very Dried seeds are susceptible to mechanical damage and injury (broken and crushed), Causes physical damage or breakage of the base seed part. Shattered Seed coats allow early and easy access to seed-forming microflora susceptible to fungal attack and reduced storage potential (FAO,2018)

III.1.3 Warehouse storage

Maintain seed quality and seed longevity in warehouse Depends on initial seed vigor, initial moisture content and combination Temperature and relative humidity during storage. Manage Behavior during warehouse storage (e.g. temperature regulation). and relative humidity) can only be established on the initial seed quality. Deterioration Reduction of seeds during storage is unavoidable, but the rate of decline depends on Initial seed quality

-The ratio of time that seeds with high initial vigor retain their quality in storage Seeds with low initial vigour.

- Vigorous and undamaged seeds can be stored longer than damaged seeds.

-Seeds that develop under conditions of environmental stress (e.g. drought, nutrient deficiencies and high temperatures) are more susceptible to Rapid deterioration.

-Seeds that are broken, cracked or bruised from handling are more likely to spoil Stores faster than undamaged seeds (e.g. cracks create access to seeds pathogens) (FAO. 2018)

III.1.4 Transport and transit

Seeds are in a "storage state" during transport and transit. At the dealer or produce dealer and at the farmer before planting. All Take steps to fully maintain the quality of the seeds Time to plant in good soil conditions to aid germination and seedling growth. Treatment-related seed storage principles and management of the storage environment remains the same, whether or not Seeds are in warehouses or on the premises of produce dealers or farmers (FAO. 2018)

III.2 The purpose of seed storage

The purpose of seed storage is to keep the seeds in good physical and healthy condition The physiological state of farmers from harvest to sowing. For most crops, there is a time lag between harvest and sowing; seeds must be Saved somewhere in the meantime, so it needs to be preserved. For some plants, seeds can be sown almost immediately after harvest, and rarely or no storage required (Delouche.2018 ;FAO,2018)

III.3 Main Storage Techniques

III.3.1 Bulk Storage

The grains can be stored and preserved in bulk in both vertical and horizontal warehouses. In this method surface of loose grains (wheat, barley, rye, oats, corn, chickpeas and lentils) are properly aligned. It is the ability to store more grain on the surface of the unit. It also makes it easier to control grain samples, has less labor costs and saves time (Pekmez,2016)

III.3.2 Storage Underground

Underground pits can allegedly hold crops without the need for years of damage. pits keep the grain cool, and Some of them are relatively airtight. above grains and However, it usually gets moldy on the sides. Exist In this method, hay, straw, polyethylene, aprons, etc. are all Put under and on top of cereal beforehand Cover with dirt. This technique provides grain Avoid contact with air, oxygen (O_2) during storage period. However, weather conditions and The location of the floor should not be carefully considered Damaged by grain. now, Grain should not be stored underground industry (Pekmez,2016)

III.3.3 Storage in Bag

Certain types of grains (rice, flour, beans, etc.) are not suitable for long-term storage in bulk storage so they can be stored in sacks (sacks) quality. Moisture content of grains is critical factors of this technique. If the moisture content is Grain increase, number of sacks in food supply Reduced. Using this method, it is easy to number them sacks and sampling from each sack, but that's how it goes Difficult to control the product as they are in the bag. In addition, less grain is stored per unit area compared to mass storage technologies. That The procedure is also more expensive due to high labor costs More time consuming, resulting in lighter rodents damage (Pekmez,2016)

Figure10. Storage in Bag (ITGC- Tiaret, 2021).

III.3.4 Storage in Warehouse (Shed)

Sheds are commonly used for bulk handling. businesses, but require careful site preparation, labor for handling large canvases and machinery to move grain in and out of the grain pile. effective treatment of insect infestation is difficult in sheds and bunkers. For farm storage, bagged grain may be a more suitable option short-term alternative . For storage in warehouse, location determination, control of moisture content and sufficient aeration supplement of cereals are important factors. The cereal and the cereal Products can be stored as bulk stack and also in bags in this technique. Insect damage is the most common problem in warehouses (Pekmez,2016)

Figure 11. Storage in Warehouse (Shed)

III.3.5 Storage in Silo

The most preferred storage technology in plants is Store grain in silos. it has many benefits Less labor costs and less time-consuming dependencies Facilitate unloading and conveying of grains Observe hygienic conditions during these procedures. Because the silo is vertical, more product is stored Unit area. There are three types of silos Wood, concrete and steel. Wooden silos are not suitable preserved as they are susceptible to fire and Conducive to the survival of insects. is a concrete silo Ideal for storing grains as less labor is required cost and less storage time. Steel silo (Figure 11) Galvanized silos are the most commonly used bearings, Because they are more resilient and easier to control compared to others. wheat, barley, rye, Oats etc can be easily stored in concrete and steel silos (Pekmez,2016)

Figure 12. Storage in Silo

Expremental Part

Chaptre 04

Material and method

1.Objective of the study

The objective of this work is to study the effect of storage time on the germination of durum wheat *(Triticum Durum)* of a single variety (Bousalem) from four different storage Period and to determine the effect of salinity on the germination of durum wheat (*Triticum Durum*).

2.Setting up the experiment

This experiment was carried out at the level of the greenhouse at the level of the National Institute of Professional Training of Tissemsilt and at the level of the laboratory of the Faculty of Sciences and Techniques of the University of Tissemsilt

3. Plant material

The plant material used in this work consists of a single variety of durum wheat (Boussalem) with 4 different storage periods (2016-2017/2017-2018/2018-2019/2020-2021). We provided the seeds from the ITGC of Sebaine (Tiaret).

We chose this variety because of their better germination rate and fast growth.

Figure13.seeds of the boussalem variety (Original)

3.2 Seed preparation and sowing

We prepared 36 cylinders and we put pebbles at the bottom (15cm) then we put the sand on top (we disinfect the sand by irrigation with bleach)

Figure14.disinfect with bleach (Original)

4. germination conditions

The experiment consists of 36 cylinders divided into three repetitions for each date.

Put three grains in each cylinder and each cylinder contains 3 repetitions, the grains are placed 1.5cm deep and start irrigated 3 times a week with tap water.

After 15 days of sowing prepare a nutrient solution (put 100g of solution in 10L of tap water) and irrigate with a plastic cup 3 times for each cylinder

Figure 15. Ingredients nutrentsolutionand irrigation (Original)

5. At the laboratory

Prepare NaCl solutions of different concentrations (0% control, 50% and 100%)

For 0mM concentration: only distilled water

For 50mM concentration: We put 2.92g of NaCl in 1L of distilled water and stir with a magnetic stirrer.

For 100mM concentration: We put 5.85g of NaCl in 1L of distilled water and stir with a magnetic stirrer.

After preparing the solution, irrigate according to the following method

At each date irrigated three times (three repetitions), three with distilled water, three with 50% concentration and three with 100% concentration

The amount of irrigation is 100mL to avoid osmotic shock.

At the laboratory

this experiment is carried out in plastic petri dishes.

5.1 Laboratory equipments

Petri dishes, beaker, stirrer, distilled water, NaCl (sodium chloride), oven, filter paper, pipette, precision balance, burette.

6. Solutions with Lavender Hydrolos

In this experimentation we used *(Lavandula stoechas)*

We obtain the cuts of the leaves and the fine branches of lavender and let dry in an oven until a degree of drying allows the extraction or let dry naturally 30 g, we put the last in the balloon of the hydro distiller for 6 hours after the operation of the extraction we separate Lavender oil, the solution remains in the Paule lamp is the hydrosol of lavender.

Figure 16. Preparation of the solution of hydrolos (Original)

7. Method

7.1 Preparation of the solutions

We prepared two solutions, one with NaCl and the second with Lavender Hydrolos

In a petri box that contains double paper, we put 10 seeds of durum wheat of the Boussalem variety and we soak according to the following method :

Each date we will apply three doses of NaCl (0mM,50mM,100mM) and repeat the operations three times for each one.

With a pro-pipette, soak 10ml of each concentration in each petri dish

Incubate the dishes in the oven at a temperature of 25 C°

After 24 hours, the imbibition dose is changed to 8ml

After 48 hours reduce the imbibition dose to 4ml

After 72 hours we will start measuring the length of the radicles and coleoptiles and we will weigh the weight of the germinated seeds.

8. The biochemical aspect of germination:

8.1 Dosage of soluble sugars

100 mg of germinated seeds from different environments are soaked for 24 hours in 5 ml of 80% ethanol. In clean test tubes, put 2mL of the solution to be analyzed, add 1mL of 5% phenol (the phenol is diluted in distilled water). then, 5mL of 96% concentrated sulfuric acid was quickly added,

avoiding pouring the acid against the walls of the tube. an orange-yellow solution is obtained on the surface, it is vortexed to homogenize the color of the solution.

The tubes are left for 10 minutes and placed in a water bath for 10 to 20 minutes at a temperature of 30°C (the color of the reaction is stable for several hours.).

Absorbance measurements are performed at a wavelength of 485 nm.

9.Characterization of lavender hydrosol:

9.1 Total polyphenols

The dosage of total polyphenols was carried out according to the Folin-Ciocalteu (FC) method [18]: 100 µl of artichoke extract are mixed with 500 µl FC reagent and 400 µl 7.5% (m/v) Na_2CO_3. The mixture is shaken and incubated in the dark and at room temperature for ten minutes and the absorbance is measured at 725 nm by a UV spectrophotometer (Perkin Elmer). The results are expressed in mg gallic acid equivalent/g of dry plant matter with reference to the calibration curve of gallic acid.

9.2 Flavonoids

The determination of total flavonoids was carried out according to the method described by (DEHPEUR et al, 2019) 500 µl of each extract to be analyzed are added to 1500 µl of 95% methanol, 100 µl of 10% $AlCl_3$ (m/v), 100 µl of 1 M sodium acetate and 2.8 ml of distilled water. The mixture is stirred and then incubated in the dark and at room temperature for 30 min. The blank is produced by replacing the extract with 95% methanol and the absorbance is measured at 415 nm using a UV spectrophotometer (Perkin Elmer). The results are expressed in mg quercetin equivalent/g of dry plant matter by referring to the quercetin calibration curve.

Chaptre 05

Interpretation of the result

1. The physico-chemical parameters of germination

1.1. Parameters measured without hydrosol application

1.1.1. Imbibition Rate Evolution Parameters

In this analysis we used software of ANOVA

The analysis of the obtained results (Tab.01), indicates that the variations in the quantity of absorbed water by the seeds are not influenced by the adopted saline treatment ($p>0.05$).

However, the year of storage has a significant influence on the expression and variations in water absorption levels at 12h and 48h after germination ($p<0.001$).

The interaction of the saline treatment with the year of storage does not allow any variations in the water uptake by the grains ($p>0.05$). This indicates that the seeds of the different years express convergent responses in reaction to the variations in the levels of the experienced saline levels.

Table 01. Analysis of variance of the imbibition rate evolution of germinated seeds

Source of variation / Trait	Year	Salin traitement	salin traitement *Year interaction
Imbibition rate after6h	0,164023ns	0,647470ns	0,031107*
Imbibition rate after12h	0,028695*	0,751812ns	0,138687ns
Imbibition rate after24h	0,790738ns	0,178077ns	0,091145ns
Imbibition rate after30h	0,610418ns	0,699031ns	0,072971ns
Imbibition rate after36h	0,540721ns	0,992885ns	0,027190*
Imbibition rate after48h	0,000105***	0,585311ns	0,194088ns

1.1.2 Imbibition rate

The obtained average results (tabl01.) show that the most absorbed imbibition value after 48 hours of germination is recorded by seeds of the year 2017-2018. While the lowest value is observed for seeds of 2020-2021.

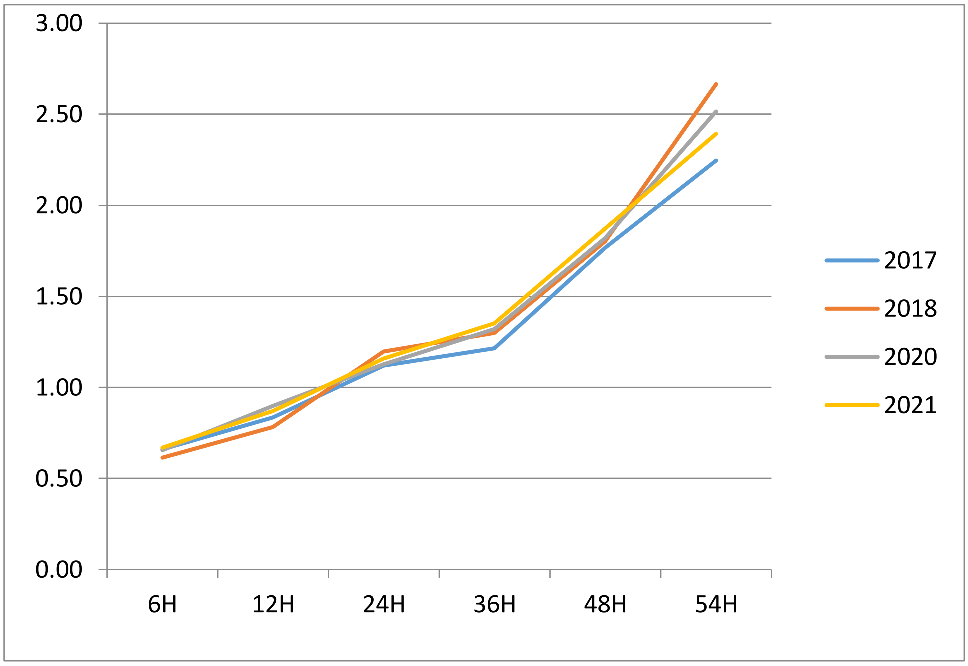


Figure17 Mean evolution of imbibition rate of seeds (%).

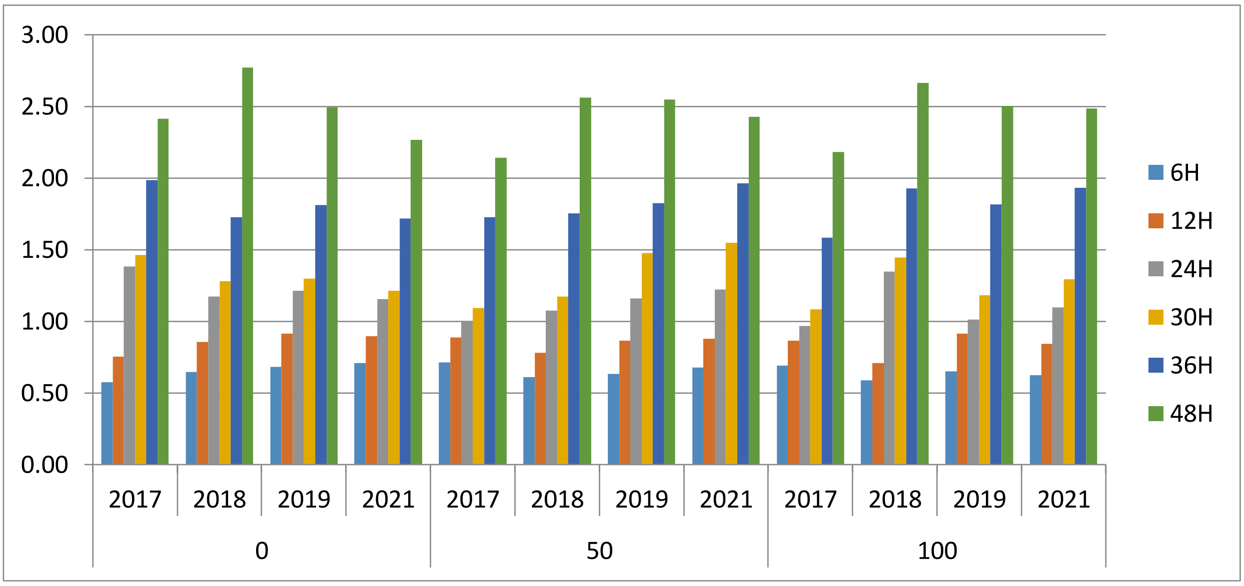


Figure 18. Imbibition rate (%) depending on the year of storage and salinity

The obtained average results show that the highest imbibition rates are revealed in the seeds of the control after 24 hours of germination. Whereas, seeds subjected to 100% salt stress exteriorized the highest amount of absorbed water compared to the 50% treatment.

1.1.3 Germinated seeds rate

The obtained results (Tab02) demonstrate that this parameter is significantly influenced by the date of the year of storage ($p<0.001$). The influence of saline levels is perceived in similar ways by the year of storage ($p<0.001$).

Table 02. Analysis of variance of seed germination rate..

Source of variation / Trait	Year	Salin traitement	Salin traitement year interaction
Germinated seeds rate after24h	0,016832*	0,172881ns	0,929025ns
Germinated seeds rate after48h	0,002949**	0,171395ns	0,702318ns

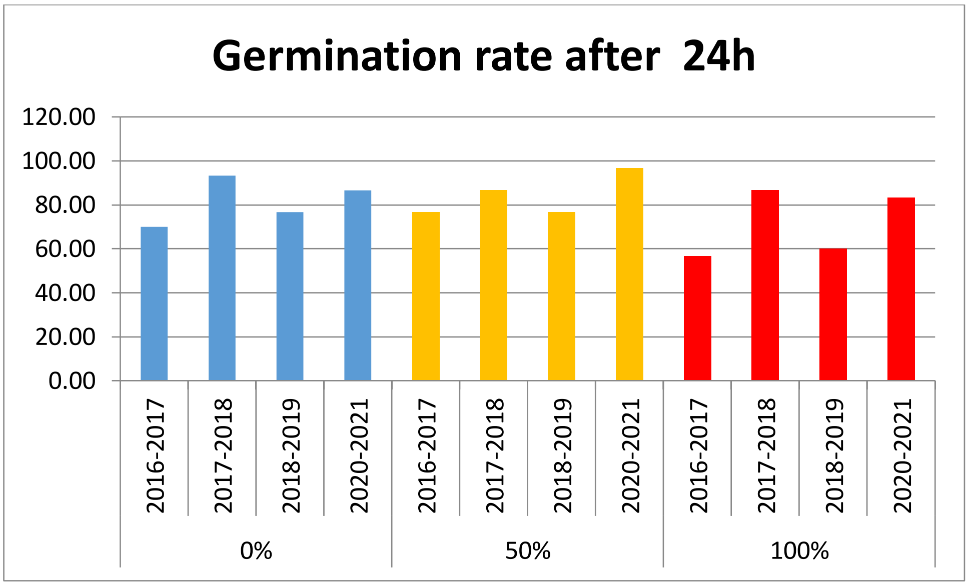


Figure19. Germination rate (%) after 24 h of germination according to the year of storage and different salinity levels.

The estimated germination rate at this phase (after 24 hours), is higher at 50% of NaCl with an expressed average by all the seeds of 84.2%. Whereas, at the level of the treatment with a concentration of 100%, the seeds exteriorized the lowest rate with 71.7%. According to the results, the seeds of the year of 2021 expressed a higher germination rate (89%) compared to the other years of storage.

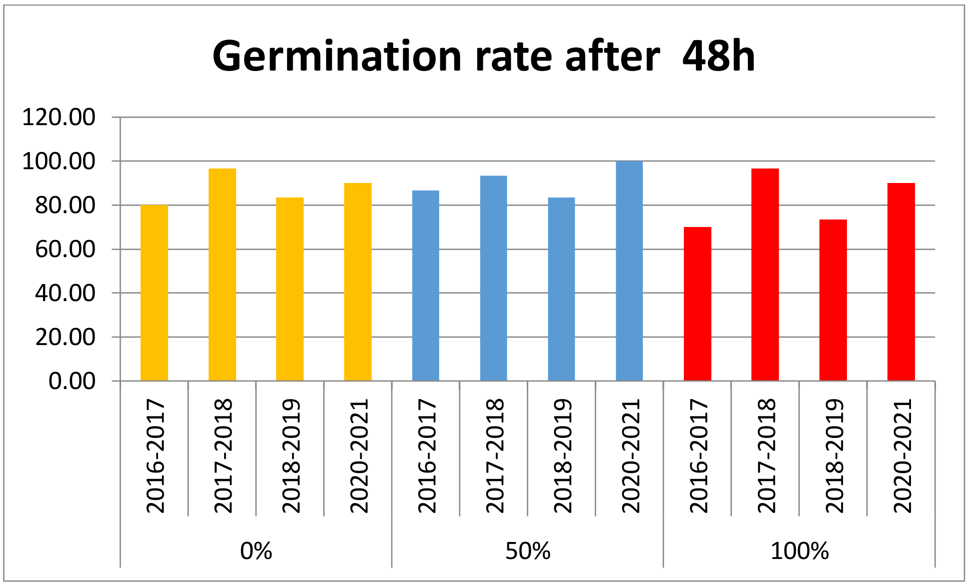


Figure20. Germination rate (%) after 48 hours of germination according to the year of storage and different salinity levels.

After 48 hours of the germination process, behavioral variability appeared in the progress of the development phase.

At the level of the control, the germination rate reached the maximum (96%) for the seeds of the year 2018.

On the scale of the treatment carried out at 50%, the highest rate is held by the seeds of the year 2021 (100%). On the other hand, the seeds of the year 2017 recorded the lowest rate (86%).

At 100% of NaCl, the range of inscribed values are delimited by 70% in 2017 and 96% registred by the seeds of the year 2018.

1.1.4 Main root length

The analysis of the obtained results (Tab.3) shows that the variations in the length of the main radicule occur in a manner dependent on the applied salinity ($p<0.001$). The variation of the year of storage has no effect on the length of expressed radicle ($p<0.001$).

These results indicate that salt stress affected the seed of genotype from different years of storage for the development of this parameter, in an indistinct manner. This is proven by the absence of any effect of the interaction of these two tested factors on the variations in the radicle length ($p>0.05$).

Table 03. Analysis of variance of main root length.

Radiculelength	df	MS	F	P
Year	3	0,4551	2,536	0,080627ns
SS (Stress salin)	2	5,6858	31,686	0,000000***
Year*SS	6	0,1373	0,765	0,604383ns

Ns non significant, ***very highly significant at0.001%

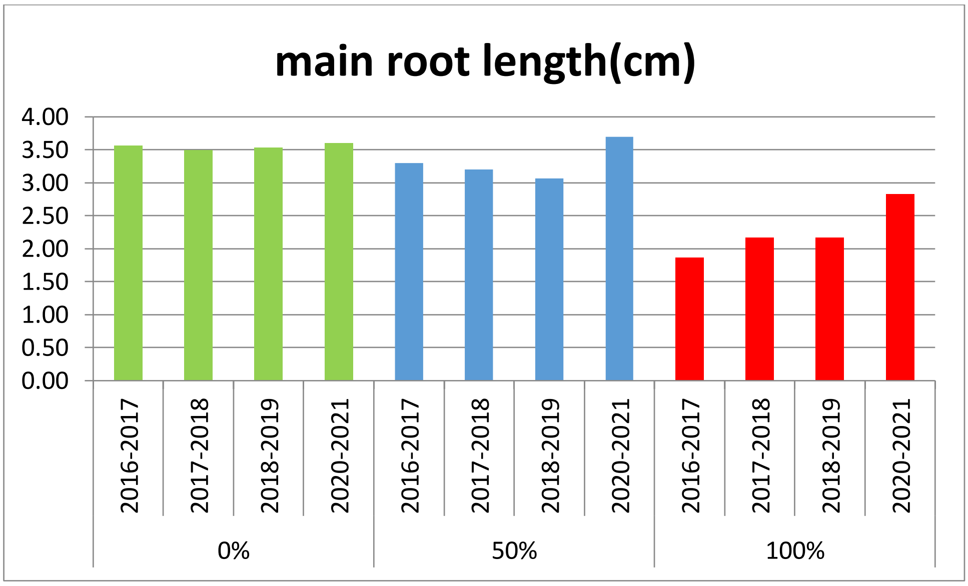


Figure21. Main root length (cm) as a function of storage year and different salinity levels.

The average of the radicle lengths of all the tested seeds are of the order of 3.6, 3.3 and 2cm, expressed respectively in the treatments carried out at 0, 50 and 100% of NaCl.

At the level of the control (distilled water), the lengths are between 3.6cm, maximum value, given by the seeds of 2021 and another minimum 3.5cm, shown by the seeds of the year 2018.

At 50%, the studied genotype presents values which vary between 3.07cm (2019) and 3.7cm for the seeds of the year 2021.

In the germination medium with a saline level of 100%, the development of this characteristic is low for the seeds of 2017 (1.7cm). While the highest root length was recorded (2.83cm) in 2021.

1.1.5 Coleoptile length

The study of the results (Tab.04), demonstrates that the development of the coleoptile length is greatly conditioned by the saline level applied ($p<0.001$).

The effect of the variation of the year of storage proves to be reliable on the obtained results (p>0.05). Indeed, the interaction of the increase in salinity in the germination medium and the year of storage does not induce any variation in the values of this length (p>0.05).

Table 04: Analysis of variance of coleoptile length.

Radiculelength	df	Ms	F	*P*
Year	3	0,08250	1,632	0,208306ns
SS (Stress salin)	2	1,18778	23,495	0,000002***
Year*SS	6	0,05444	1,077	0,403660ns

Ns non significant, ***very highly significant at 0.001%

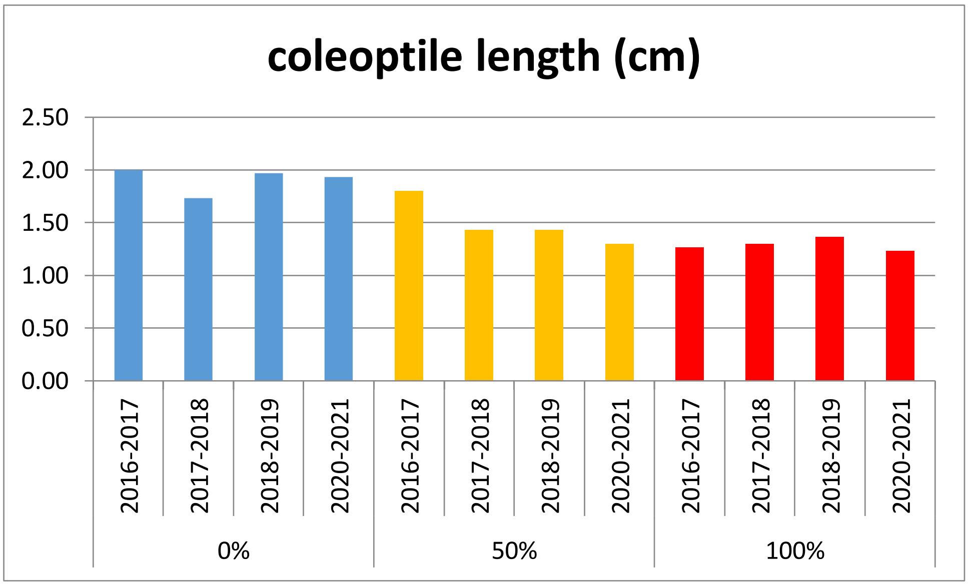


Figure22. Coleoptile length (cm) as a function of storage year and different salinity levels.

The average results (Fig22.), indicate that the coleoptile length varied significantly with the recrudescence of saline level, thus the longest coleoptiles are recorded at the level of the control treatment (0% of NaCl), with an average value of 1.9cm. Nevertheless, the increase in salt stress in the germination medium results in a marked reduction in the values of this length. Thus we evaluate the reductions at -21 and -31% respectively in the treatments carried out at 50% and 100% of NaCl.

1.1.6 Number of roots

The analysis of the obtained results (Tab.5) of the number of formed roots after germination, reveals that the variations of this characteristic take place in a manner dependent on conducted saline treatment (p<0.05). Variations in the year of storage do not induce any variation on the number of roots (p>0.05).

Table 5. Analysis of variance of the number of emerged roots.

Radicule length	df	Ms	F	*P*
Year	3	0,3241	0,4167	0,742619ns
SS (Stress salin)	2	3,0278	3,8929	0,034336*
Year*SS	6	0,2130	0,2738	0,943773ns

Ns non significant ,*significantat 5%

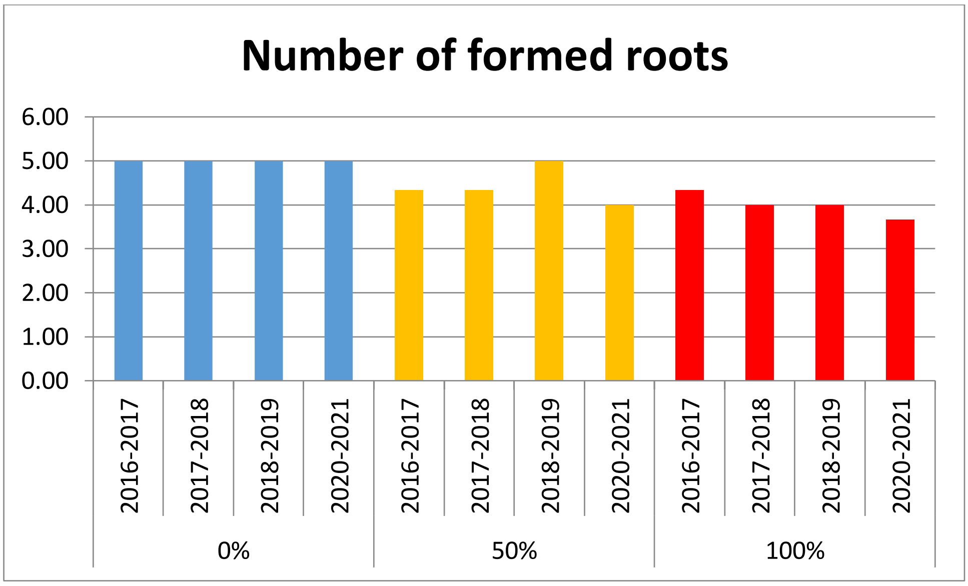


Figure23. Number of formed roots depending on the year of storage and different salinity levels

The average results illustrated in (fig 23), show significant variations in the number of roots that appeared through the different saline treatments. Indeed, the increase in the level of salinity contributes to a clear reduction in this number. In general, it is at the level of the control (0% of NaCl) that the values of the roots are the highest with an average of 5 roots/plant. The reductions recorded in the 50% and 100% treatments are evaluated at -11 and 20% respectively.

1.1.7 Soluble sugars

The variance analysis of the obtained results (Tab.5) of accumulated sugars after

24 hours of seed germination, reveals that the variations of this characteristic operate independently of the conducted saline treatment (p>0.05) .The variations in the year of storage do not induce any modification of this parameter (p>0.05).

Table6. Analysis of variance of the level of accumulated sugars after 24 hours of germination.

Radicule length	df	Ms	F	*P*
Year	3	2500,9	1,8006	0,174005ns
SS (Stress salin)	2	3682,8	2,6515	0,091114ns
Year*SS	6	867,6	0,6246	0,708900ns

Ns non significant

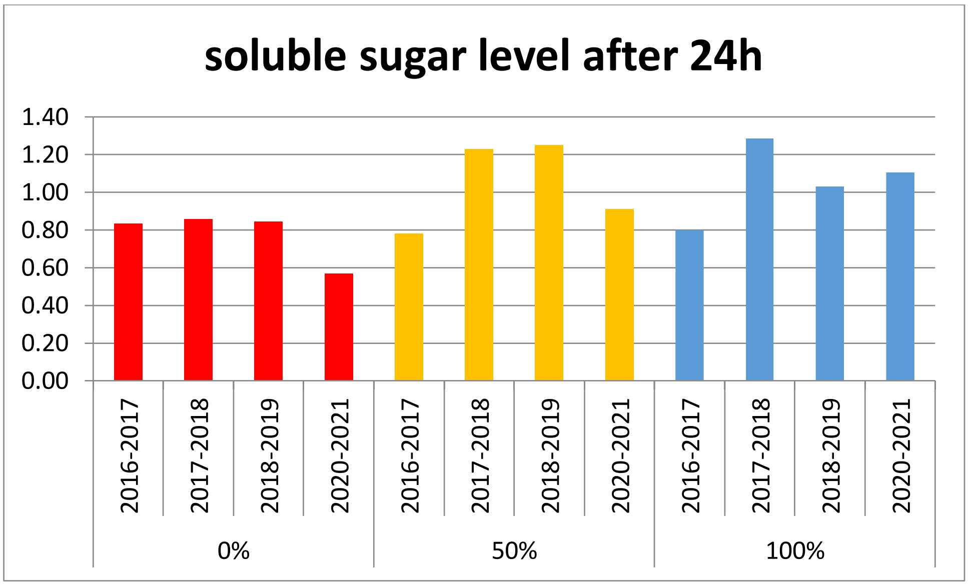


Figure 24.Average evolution of the soluble sugar content of the seeds (mg/100g.MF) according to the year of storage and the salinity.

Generally and according to the results of this parameter (Fig24), the sugar content increases from the control (0%) to high salinity level (100%).

At the level of the control, the highest value is observed in seeds of the year 2018 (0.9mg/100mg.FM). In contrast, the seeds of the year 2021 recorded the lowest sugar content with a value of 0.57mg/100mg.FM.

In the treatment conducted at 50%, the seeds of the year 2019 recorded the highest sugar level with a content of 1.25mg/100mg.MF.

In the lot conducted at 100%, the sugar contents are higher, in comparison with those noted in the control and lot at 50%. Thus, the seeds of the year 2018 externalize the highest value with 1.3mg/100mg.MF.

2. Trial conduct in the greenhouse

2.1 Number of tillers

The variance analysis of the obtained results (Tab07) of the number of tillers, reveals that the variations of this characteristic operate independently of the saline treatment carried out (p>0.05). The variations in the year of storage do not induce any modification of this parameter(p>0.05).

Table7. Analysis of variance of the number of developed tillers

Radicule length	df	MS	F	*P*
Year	3	3,0278	0,6813	0,515ns
SS (Stress salin)	2	2,6944	0,6063	0,617ns
Year*SS	6	3,2500	0,7312	0,629ns

Ns non significant

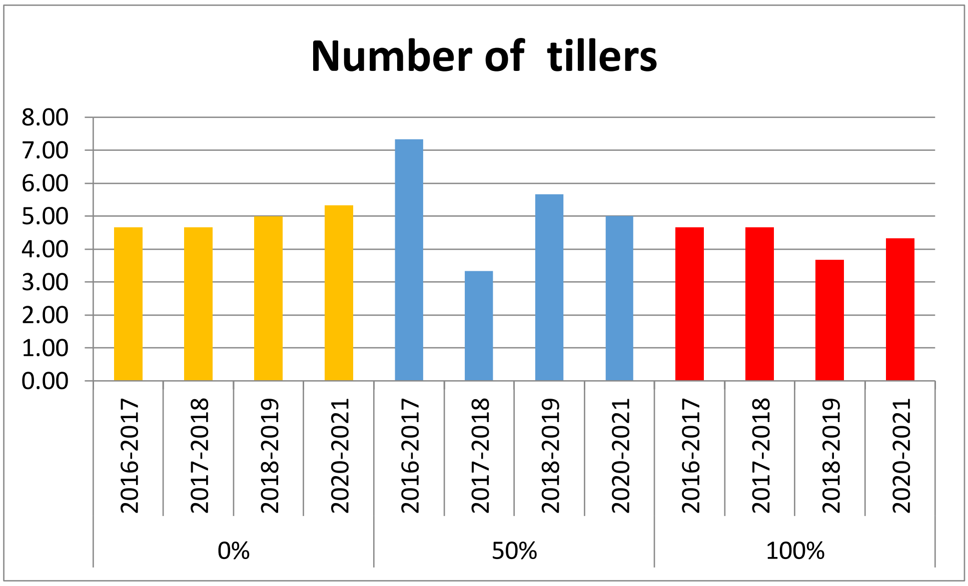


Figure 25. Number of formed tillers depending on the year of storage and salinity.

The obtained results from this characteristic showed that the highest average value is recorded by plants subjected to a saline level of 50% (5.3 tillers), while the lowest (4.3 tillers) is recorded by plants conducted at 100 % of NaCl.

At the level of treatment without salt stress, the grown plants from the seeds of the year 2021 showed the highest number of tillers with an average of 5.3 tillers compared to a low number recorded by the plants of the year 2017 and 2018 (4.6 tillers).

In the treatment conducted at 50%, the highest number of tillers is exteriorized by the plants of the seeds of the year 2019 with 5.67 tillers, against a low value of around 3.33 tillers, value recorded in 2018.

In the treatment carried out with 100% NaCl, the plants of the year 2021 are distinguished by the lowest number of tillers (4.33) compared to the other storage years.

2.2 Plant height

According to the results of the analysis of variance (Tab08), it was revealed that the variations in the height of the plant is realized in a dependent manner of conductedsaline treatment (p<0.05). The variations in the year of storage have no influence on this characteristic (p>0.05).

Table8. Analysis of variance of the plant height

Radicule length	df	MS	F	*P*
Year	3	57,5	1,285	0,295ns
SS (Stress salin)	2	182,8	4,084	0,0178*
Year*SS	6	92,4	2,064	0,095ns

Ns non significant ; Significant at *p*<0.05

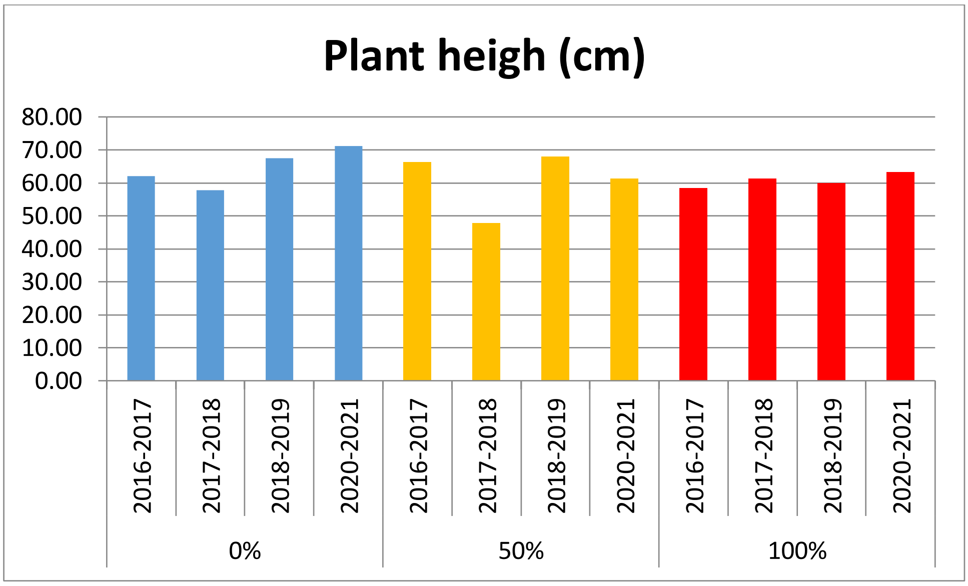


Figure 26. Plant height (cm) as a function of storage year and salinity.

The obtained results from the measurement of the final height of the plants demonstrated that the saline treatment greatly affected the expression and development of the plants registering average values of 64, 60.9 and 60.7 cm at the concentrations 0%, 50% and 100% respectively. Thus, it turned out that the plants of the storage year 2021 recorded higher heights compared to other years.

2.3 Ear length

According to the analysis of variance (Tab09), the final length of the ear occurs in a mannersignificantlyrelated to the appliedsalt treatment ($p<0.01$). The variations in the year of storage produce no variation in this organ ($p>0.05$).

Table9. Analysis of variance of the ear lenght

Radiculelength	df	MS	F	*P*
Year	3	0,192	0,192	0,826ns
SS (Stress salin)	2	6,001	5,996	0,003**
Year*SS	6	1,294	1,293	0,298

Ns non significant ; * Significant at $p<0.01$

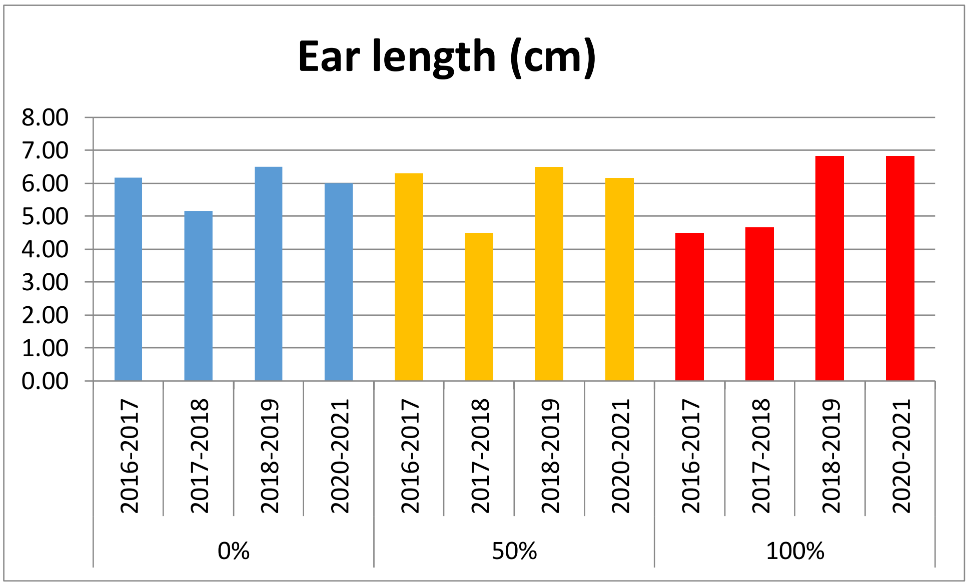


Figure 27. Ear length as a function of storage year and salinity.

The obtained results for the ear length indicated that the increase in the level of salinity significantly affected the formation of this part of the plant by registering average values of 5.9, 5.8 and 5.7cm and this at the level of the 0%, 50% and 100% treatment respectively. Thus and according to the data entered, the plants resulting from the seeds of the year 2019 are distinguished by the highest length of the ear whether it is the induced salinity with lengths of 6.5, 6.5 and 6.8 cm recorded at 0%, 50% and 100% of NaCl.

1.2. Parameters measured with hydrosol application

1.2.1. Root length

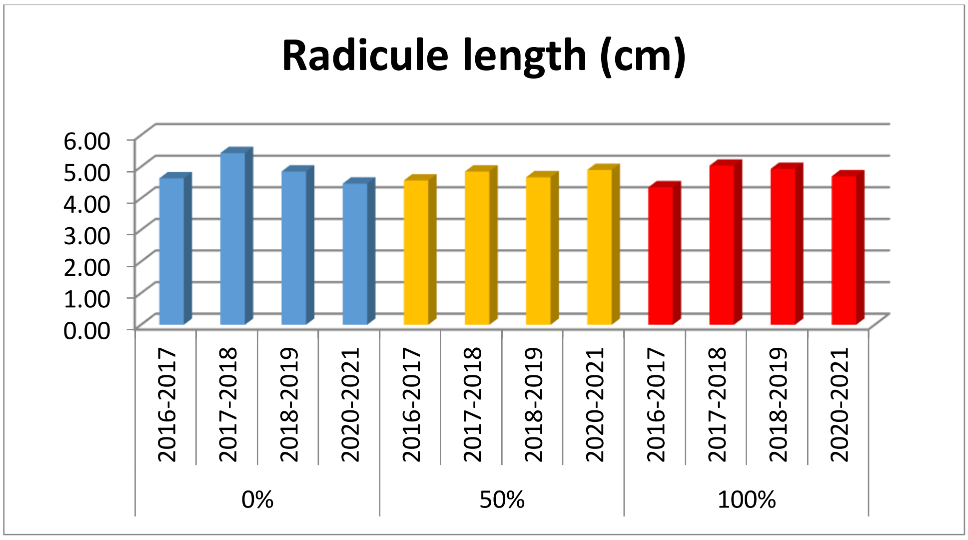


Figure 28: Radicle length as a function of storage year and salinity (salinity,hydrosol; v,v).

The results of this parameter demonstrated that the application of the hydrosol during the germination process of wheat seeds improved the status of the expression of the radical length in particular at the level of the treatment carried out with 100% NaCl.

At the control level (0% NaCl), the longest radicle length is recorded for the seeds of the year 2018 with 5.4cm compared to a low length recorded by the plants of the year 2021(4.3cm).

In the treatment led to 50%, the highest length is exteriorized by the seeds of the year 2021 with 4.9cm, compared to another minimum evaluated at 4.5cm, value recorded in 2017.

In the treatment carried out with 100% NaCl, the seeds of the year 2018 are distinguished by the highest length (5cm) compared to the other years of storage.

1.2.2. Root number

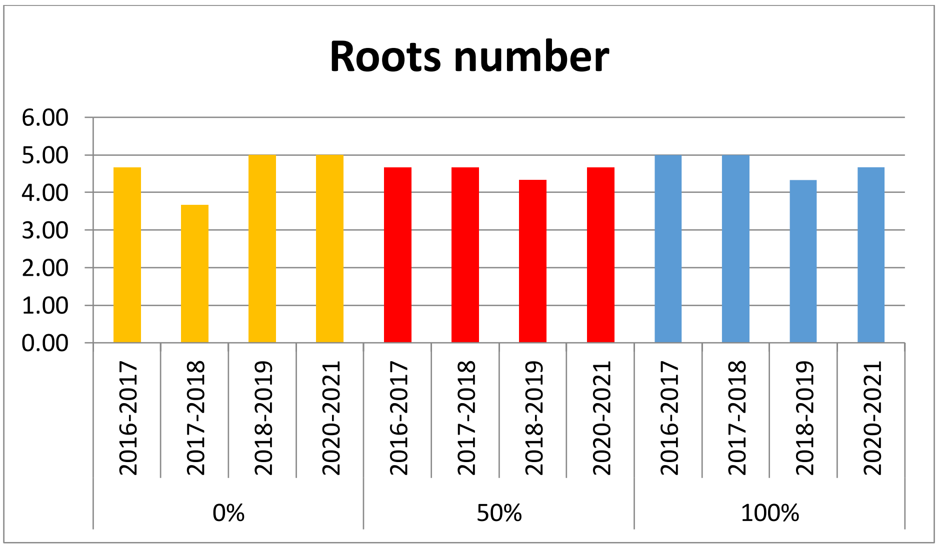


Figure 29.Roots number depending on the year of storage and salinity (salinity,hydrosol; v,v)

For this parameter, it was found that the same kinetic was exhibited as the expressedradicle length. Indeed, the highest values of the number of formed roots are recorded at the level of the treatment carried out at 100% with an average of 4.7 roots/plant.
At the level of the lot conducted at 0% NaCl), the highest number of roots is recorded for the seeds of the year 2019 and 2020 with 5 roots.

In the treatment led to 50%, the lowest number of roots is revealed by the seeds of the year 2019 with 4.3 roots, compared to another maximum (4.7) registered in 2017, 2018 and 2021.

In the treatment conducted at 50%, the seeds of the years 2017 and 2018 expressed a maximum number of roots with 5 roots/plant unlike a minimum number revealed by the seeds of the years 2019 (4.3) and 2021 (4.6).

Discussion of the result

The primary purpose of seed storage is to preserve planting stock from season to next. Thus it aims to maintain the quality of the seeds for as long as possible. In other words, seed storage enables conservation of germplasm for a plant breeding program.However, the most important factors affecting seed quality during storage are type of seed, moisture content, climatic conditions of storage location (temperature, relative humidity) and storage pests (Chala et Bekana , 2017).

The purpose of this study was to evaluate the behavior of a variety of durum wheat from different storage periodes and subjected to different concentrations of saline stress. The latter is considered to be one of the abiotic factors that greatly limits crop productivity.

The seed is the fundamental element in all agricultural production. Particularly high quality seed is a serious input on which all other inputs will depend for its full value including final yield quality and quantity (Mekonnen, 2020). The qualitative deterioration of the seeds begins not only at the start of its physiological maturity stage but also at the post-harvest stage (Sabry, 2018). This deterioration process could be related to certain physiological changes, such as a progressive decrease in the germination capacity, an increase in the average germination time and an increase in the number of abnormal seedlings and a lower tolerance to unfavorable environmental conditions (Mekonnen, 2020; Nyo, 2020).

Germination is controlled by the environmental factors, the physiological status of the seeds, and the germ interaction (Kildisheva et *al*., 2020). The need for the various abiotic factors depends primarily on the genotype in response to these surrounding abiotic factors and these abiotic factors as a collective.

The seed storage period can affect seed viability (Rao et al., 2006; Scalon et *al*., 2012), as the reduction in seed viability is directly proportional to the increase in time (Bortey et *al*. , 2016) and the loss of their reserves (Moncaleano-Escandon et *al*., 2013). Farmers in the developing world still store their produce, including seed in the ambient environment, for a longer period of time, which has been observed to affect seed quality in general and germination in particular (Isaac et *al*. , 2016). Additionally, the carried out stress saline has affected this process. High salinity leads a decrease in osmotic potential of ambient soil water, resulting with a decrease in water uptake by dry seeds.

During germination, this abiotic stress damages the nutrient and hormone balances, especially gibberellin (GA)/abscisic acid (ABA).Dynamic balance between the generation and scavenging of reactive oxygen species (ROS) such as hydroxyl radicals, superoxide, and hydrogen peroxide could be disturbed by high salinity stress. ROS damage the macromolecules including proteins, carbohydrates, nucleic acids, and lipids, or cellular structures like membranes, resulting with inhibition of seed germination (Ibrahim, 2016).

The obtained results showed that the rate of imbibition and the percentage of germination decreased in seeds having a longer storage period (Mersal et al., 2005; Singh et *al*., 2011; Nour and Brinis, 2016). This decrease was due to the natural aging process, with a consequent loss of organic solutes throughout the storage period, caused by continued respiratory activity of the seeds (Booth and Sowa, 2001; Srivastava, 2002).

Soluble sugar has been exhibited to be key osmolytes that contribute to osmotic adjustment (Radić et *al*. 2013). Also, it can enhance salt tolerance by protecting and stabilizing membranes and enzymes under saline stress (Juan et *al*. 2005, Gupta and Huang 2014). In the present study, with the increase of NaCl concentrations, seed soluble sugar concentration showed a gradually increasing trend (Fig20).

Seed germination is not only a critical developmental step in the life cycle of higher plants but also determines the failure or success of the subsequent seedling establishment and plant growth (Liu et *al*., 2010). The results of this study have demonstrated that storage time and salinity have negatively influenced the plant development.According to our study, a longer storage period was accompanied by a low accumulation of sugars. Yan (2017) showed that seed storage period was negatively correlated with accumulation of soluble sugars in cabbage. This reduction is linked to an inhibition of starch degradation (Hussain et *al*., 2015). However, this trend is explicated by the saline stress effect in the first degree. Indeed, plant high and tillers per plant were decreased significantly by saline conditions as compared to non saline conditions (Abbas et *al*., 2013; Seleiman et *al*., 2021). It may be due to absorption of excessive salts by the plants, which ultimately affected the plant growth indirectly by decreasing the amount of photosynthates, water or other growth factors (Khathar and Kuhad, 1999).

This work is considered as a first original study aimed at examining and understanding the role of by-products in the resistance of plants to salt stress. According to our results, it was demonstrated that the hydrosol resulting from the extraction of essential oils of lavender improved the germination status of seeds (Parvin et *al*., 2019; Jańczak-Pieniążek et *al*.,2021). This could be attributed to its richness in flavonoids. Plants, due to their sedentary lifestyle, are more exposed than animals to damage caused by environmental pressure. This has caused them to evolve various mechanisms that allow them to adapt to unfavourable conditions (Brunetti et *al*., 2018). As a result of exposure to stress factors, many flavonoid biosynthesis genes, including quercetin, are induced, which play an important role in plant life by regulating physiological processes (Hernández et *al*., 2008). Such substances, called bio-stimulants, are natural growth regulators that contribute to an increase in the physiological activity of plants through protein synthesis. So, quercetin, which is a strong antioxidant, provides plants with tolerance to biotic and abiotic stresses (Brunetti et *al*., 2018; Kobylińska, 2017).

Conclusion

Conclusion

Our experiment consists in studying the biochemical and morphological physiological behavior of a single variety of durum wheat (*Triticum Durum*) (Bousalem) stored in four different dates with the application of two concentrations of 50 and 100 mM sodium chloride (NaCl) , The results showed that the salinity decreases considerably, the length of radicle, coleoptile and the rate of water absorption by the grains and thus the height of the plant and the length of the ears.

Seed germination decreases sharply with the increase of NaCl concentrations, especially the concentration of 100mM NaCl, while salinity plays a negative role in germination and plant development.

lavender hydrosol has an extremely beneficial effect on the germination of grains in salt stress.

The content of soluble sugars increases relatively as a function of salinity in durum wheat (*Triticum Durum*) on the other hand, we find that there is no effect of the duration of storage on the germination and characterization of durum wheat but the preservation of the grains in the best conditions give it viability for a longer period.

Our work is only an introduction to the research of the effect of storage time and salinity on the germination of durum wheat (*Triticum durum* desf) hoping and encouraging the improvement, the development of experiments and the application of other abiotic stresses (thermal stress, water stress, etc.).

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Annexe

Table :the result of polyphenol

acide gallique	0,1 mg	0,15 mg	0,25 mg	0,5 mg	hydrosol
1	0,322	0,391	0,665	1,063	0.018
2	0,122	0,406	0,562	1,168	0.018
3	0,277	0,415	1,03	2,133	0.018

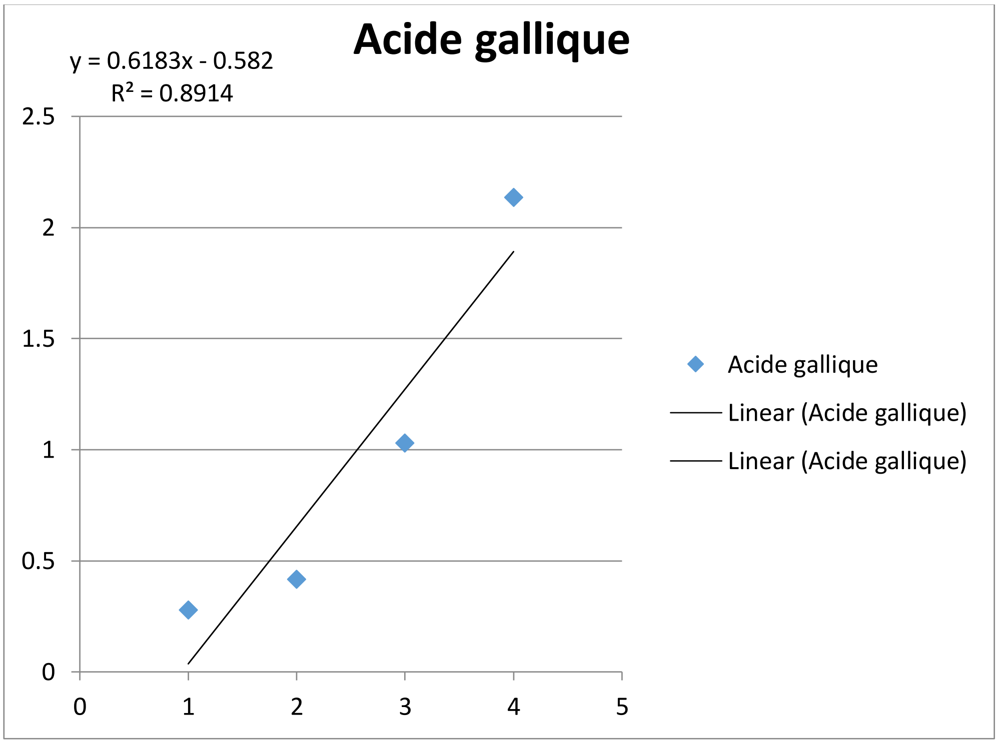

Figure :the result of polyphenol

Table : The result of Flavonoides

Querrcétine	0,1 mg	0,15 mg	0,25 mg	0,5 mg	hydrosol
1	0,075	0,119	0,173	0,215	0.144
2	0,065	0,149	0,208	0,374	0.154
3	0,017	0,025	0,052	0,064	0.146

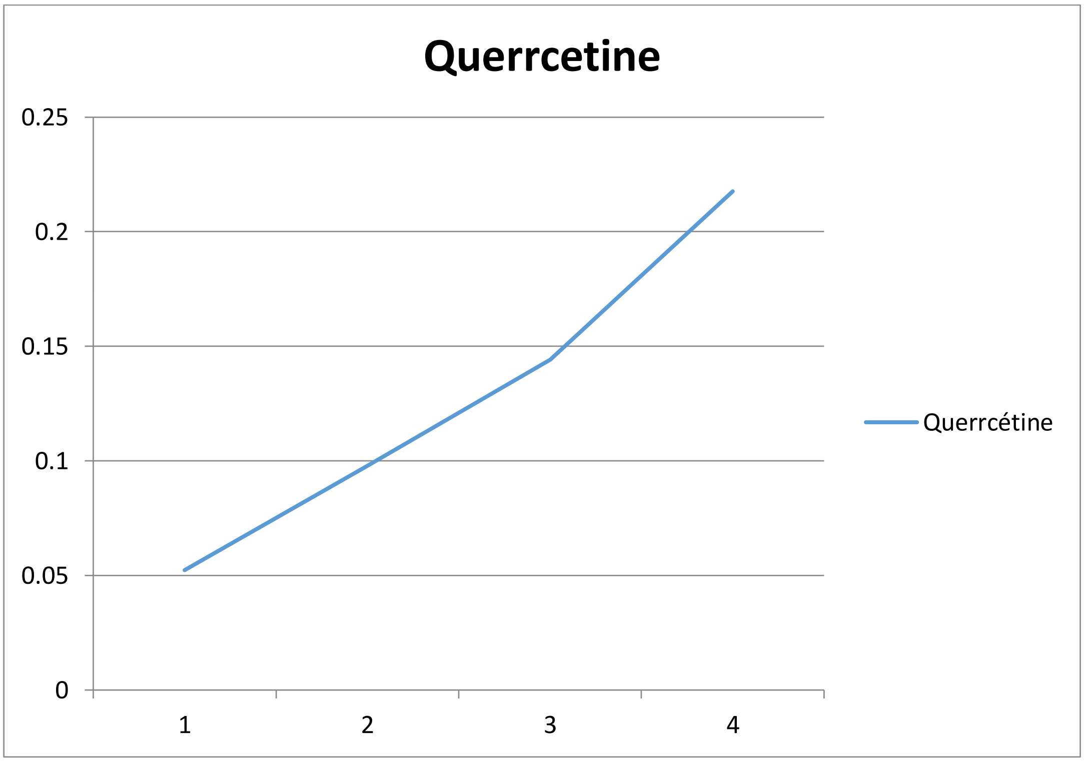

Figure : The results of Flavonoides

Resumé

Dans le but de déterminer l'effet da la durée de stockage et la salinité sur la germinaton du blé dur (*Triticum Durum* Desf) , nous avons adopté l'effet de deux différentes doses de chlorure de sodium NaCl(50 et 100mM) et quatre différentes dates de stockage (2016 ,2017 , 2018 , 2020) .

les résultats ont montré que l'augmentation des doses de NaCl a provoqué une forte diminution de la longueur de racidule , coléoptile et le poids d'absorption d'eau par la grains et ainsi la hauteur de la plante et la longueur de l'épis.et augmentation des sucres solubles accumulés dans les graines. Tandis qu'aucune différence significative n'est enregistrée en durée du stockage sur la germination de blé dur .cependant que l'hydrolat de lavande a un effet extrêmement bénéfique sur la germination des grains en stress salin.

Les mots clées : stockage, salinité, germination, l'hydrolat de lavande, grains

Summary

In order to determine the effect of storage time and salinity on the germination of durum wheat *(Triticum Durum* Desf *),* we adopted the effect of two different doses of sodium chloride NaCl (50 and 100mM) and four different storage dates (2016;2017;2018;2020)

the results showed that increasing the doses of NaCl caused a strong decrease in root length, coleoptile and the weight of water absorption by the grains and thus the height of the plant and the length of the ear. .and increased soluble sugars accumulated in the seeds. While no significant difference is recorded in duration of storage on germination of durum wheat. while the lavender hydrolos has an extremely beneficial effect on the germination of grains of wheta durum in salt stress.

Key word : storage, salinity, germination, hydrolos, seed

ملخص

من أجل تحديد تأثير وقت التخزين والملوحة على إنتاش القمح الصلب (*TriticumDurumDesf*) ، اعتمدنا تأثير جرعتين مختلفتين من كلوريد الصوديوم كلوريد الصوديوم (50 و 100 ملي مولار) وأربع تواريخ تخزين مختلفة (2016 ؛ 2017 ؛ 2018 ؛ 2020)

وأظهرت النتائج أن زيادة جرعات كلوريد الصوديوم أدت إلى انخفاض كبير في طول الجذر ، و كوليوبتيل ووزن امتصاص البذور للماء ، و أيضا انخفاض في طول النبات وطول السنبلة ، وزيادة في السكريات الذائبة المتراكمة في البذور. بينما مدة التخزين لم تاثر على انتاش القمح الصلب, في حين ان ماء اللافندر له تأثير مفيد للغاية في إنتاش بذور القمح الصلب عند الإجهاد الملحي.

الكلمات المفتاحية :مدة التخزين ,الملوحة , الانتاش , ماء الخزامى ,البذور